HOW TO RUN AN AUTOMOBILE

A concise, practical treatise written in simple language explaining the functions of modern Gasoline Automobile Parts with complete instructions for driving and care.

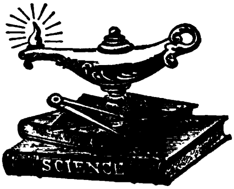
Includes

the most thorough and easily understood illustrated instructions on 1918 automobile control systems ever published.

By VICTOR W. PAGÉ, M.E.

Member Society of Automobile Engineers

Author of "The Modern Gasoline Automobile," "Automobile Repairing Made Easy," etc.



Illustrated with seventy-two specially made diagrams and authoritative photographs furnished by leading automobile manufacturers showing actual parts, all in correct proportion.

NEW YORK

THE NORMAN W. HENLEY PUBLISHING CO.

2 WEST 45th STREET

1919

PRESS OF
BRAUNWORTH & CO.
BOOK MANUFACTURERS
BROOKLYN, N. Y.

PREFACE

IN PRESENTING this little treatise to the reading public the writer wishes to emphasize that it is not intended as an instruction book on the construction or repair of automobiles. It has been prepared in answer to numerous requests for a concise exposition of the operating principles of modern gasoline automobiles. It has been thought desirable to incorporate a chapter outlining automobile construction very briefly in order that the novice may obtain some appreciation of the functions of the various parts before he learns the care and operation of the car. This book is intended as an absolutely non-technical compilation of the operating instructions of leading automobile manufacturers with which the car owner should be familiar. If a more detailed study of automobile construction or repair is desirable the reader may obtain very complete treatises and text books from the publisher of this little volume. The basic principles of gasoline motor car operation are practically the same in all types of cars though various forms of speed changing mechanism demand distinctive methods of control in each specific case. It is not possible to give definite information applying to every make of automobile but the types that are illustrated are representative of standard practice and the general advice given can be applied to all cars, especially the instructions relating to motor speed control and gear shifting. A careful study of the illustrations will serve to make clear many points that may not be fully explained in the text.

Victor W. Pagé.

March, 1917.

TABLE OF CONTENTS

CHAPTER I

AUTOMOBILE PARTS AND THEIR FUNCTIONS

CHAPTER II

GENERAL STARTING AND DRIVING INSTRUCTIONS

CHAPTER III

TYPICAL 1917 CONTROL SYSTEMS

King Eight — Kissel-Kar — Maxwell — Marmon — Mitchell — National—Oakland Model 32—Oakland Model 50—Overland 75—Overland 85—Packard Twin Six—Paige—Pierce Arrow—Reo—Stearns-Knight—Studebaker—Scripps-Booth—Velie.

CHAPTER IV

CARE OF AUTOMOBILES

Winter Care of Automobiles—Maintenance of Body and Upholstery—Care of Storage Battery—Tools and Repair Equipment—General Supplies—Motor Troubles—Road Repair of Tires—Extricating a Mired Automobile.

CHAPTER I

AUTOMOBILE PARTS AND THEIR FUNCTIONS

How Automobile Chassis is Divided into Groups—Gasoline Engine Types—Automobile Engine Parts—Cooling Systems—Carburetion System—Ignition Methods—How Engine is Lubricated—Power Transmission Parts, Clutch and Gearset—Frame Parts—Rear Axles and Brakes—How Automobiles Are Steered—Electric Starting and Lighting System—Wire Wheels—Pneumatic Tires and Rims.

How Automobile Chassis is Divided into Groups.—In order to deal systematically with the subject of motor-car construction, one may divide the essential mechanism into groups and treat each of these assemblies in detail. In order to understand the functions of the various parts, views of typical pleasure car chassis of latest design with all components clearly indicated are presented. These show conventional arrangements of parts in vehicles which are adapted to a wide range of work. Of the many elements comprising the automobile, the source of power is the most important. Then comes the method of power transmission, and last the various chassis parts which have to do with suspension, control, etc. By referring to illustrations, which show the construction of typical gasoline car chassis clearly, the functions of the various parts and their relation may be easily understood.

The basis of any conveyance, whether animal drawn or power propelled, is a running gear. That of automobiles consists of a frame supported on springs which rest on the axles, which in turn carry the wheels on which the whole assembly can roll over the ground. In a horse drawn carriage, where there is no necessity for a heavy or strong supporting frame, and because of the light weight of the body, it is possible to attach the springs directly to the sills on which the body rests. In a motor vehicle,

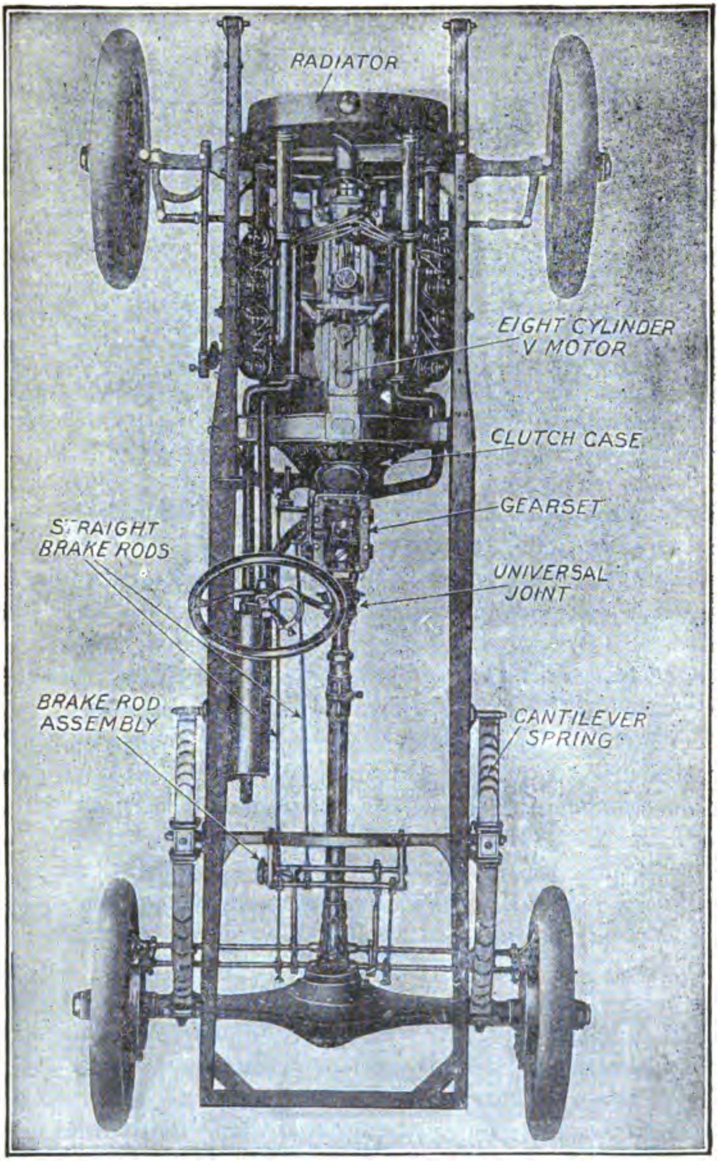


Fig. 1.—Plan View of the King Eight Cylinder Chassis, Showing Arrangement of Parts.

however, the frame is usually separate from the carriage work, because it is often necessary to remove the body to gain access to some portion of the mechanism which may need attention. The frame of an automobile must be strong because the engine and some of the parts of the transmission system are installed thereon, and also because the speed possibilities of the automobile make it necessary that the frame be of sufficient strength to resist the stresses due to car movement and frame distortion when driven over uneven road surfaces. These strains are not present in other forms of conveyances. The locomotive, which is capable of high speed and which is very heavy, travels on a smooth track, while ordinary horse drawn carriages are not affected materially by the roughness of the path on which they travel because of their low speed and light weight.

In the frame, or chassis group, one may include the main frame, sub-frame, steering gear, clutch and brake pedals, hand levers for varying change speed gear ratios and applying emergency brakes; the front axle and its steering connections, the driving axle and brakes, the wheels, the tires, and the springs which form a yielding connection between the axles and the frame.

The power plant of a gasoline automobile is composed of a number of distinct devices of which the engine proper is the most important, though all of them are necessary to insure practical operation. In order to describe power plant construction logically, it may be divided into six distinct parts or groups of which all are composed. The most important assembly is the motor; then the gas supply system, the ignition apparatus, the devices used for lubrication, the system of cooling and the muffler assembly. The power transmission mechanism is the next group of importance. In this assembly one places the clutch, the gearset, the driving means, and, in most instances, the rear axle and traction members.

Parts of Typical Automobiles and Their Functions.—A brief explanation of the function of each important part of the gasoline car chassis depicted at Figs. 1, 2, 3 and 8 will serve to afford a better understanding of the construction of the modern auto-

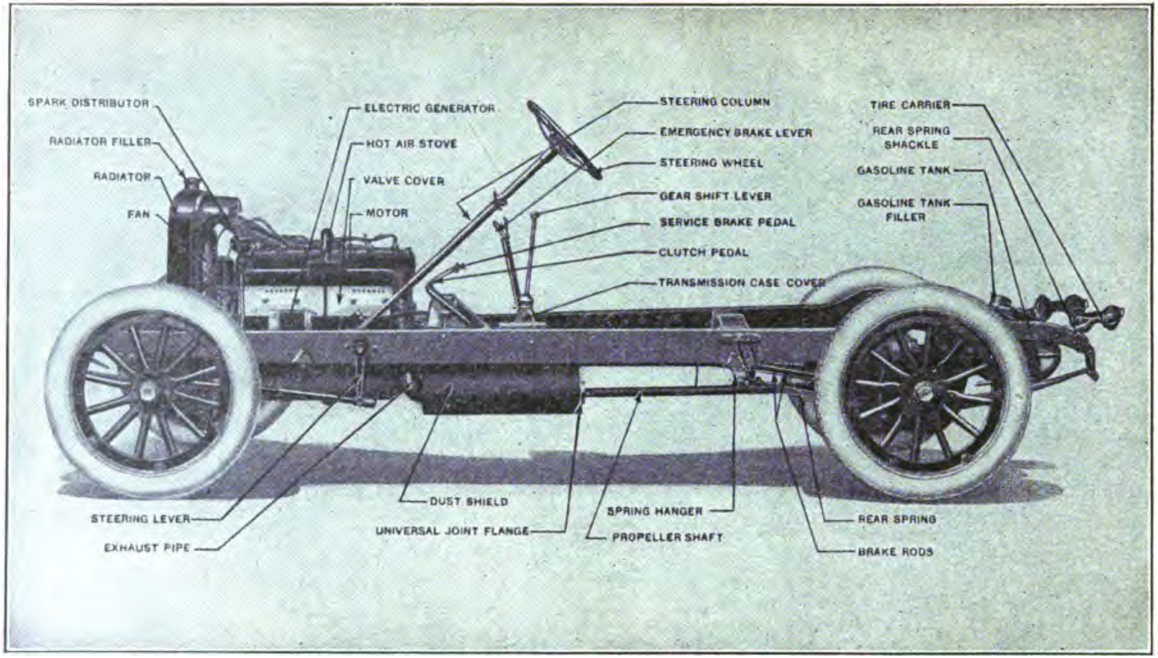


Fig. 2.—Side View of Chalmers Light Six Touring Chassis, Showing Simplicity of Motor Cars of Latest Design.

mobile. The purpose of the front axle is not unlike that of a horse drawn vehicle, but it is much different in construction. The wheels are installed on movable spindles, or steering knuckles, which are supported by yokes permitting one to move the wheels for steering rather than turning the entire axle on a fifth wheel, or jack-bolt arrangement, as in a horse drawn vehicle. This axle is attached to the frame by spring members which allow a certain degree of movement without producing a corresponding motion of the frame. The radiator, which is placed directly over the axle in front of the motor, is employed to hold the water used in keeping the engine cool and is an important part of the heat-radiating system. The starting handle is a crank by which the motor crank shaft is given sufficient initial movement by the operator to carry the engine parts through one or more portions of the cycle of operations, this starting the engine. Nearly all cars now have electrical starting means except the Ford. The tiebar joins the arms of the steering spindles on which the wheels revolve, and insures that these will swing together and in the same direction, either to the right or left. The steering link, often called the "drag link," connects one of the steering knuckles of the front axle with the steering gear. The motor may be one of the many forms to be described and one of many distinct types. The dash is a wooden or metal partition placed back of the power plant to separate the engine from the seating compartment. It is often employed to support some of the auxiliary apparatus necessary to motor action or some of the control elements.

The clutch is a device operated by a pedal, which permits the motor power to be coupled to the gearset and from thence to the driving wheels, or interrupted at the will of the operator. It is used in starting and stopping the car and whenever the change speed gears are shifted. The accelerator is a small pedal which actuates a valve on the gas supply device to permit more explosive mixture being fed to the engine when it is desired to increase the motor speed. Its function is comparable to that of the throttle of a steam engine. The pedals are foot-operated levers; one of which releases the clutch, the other applies the service brakes. The motor control levers on the steering column

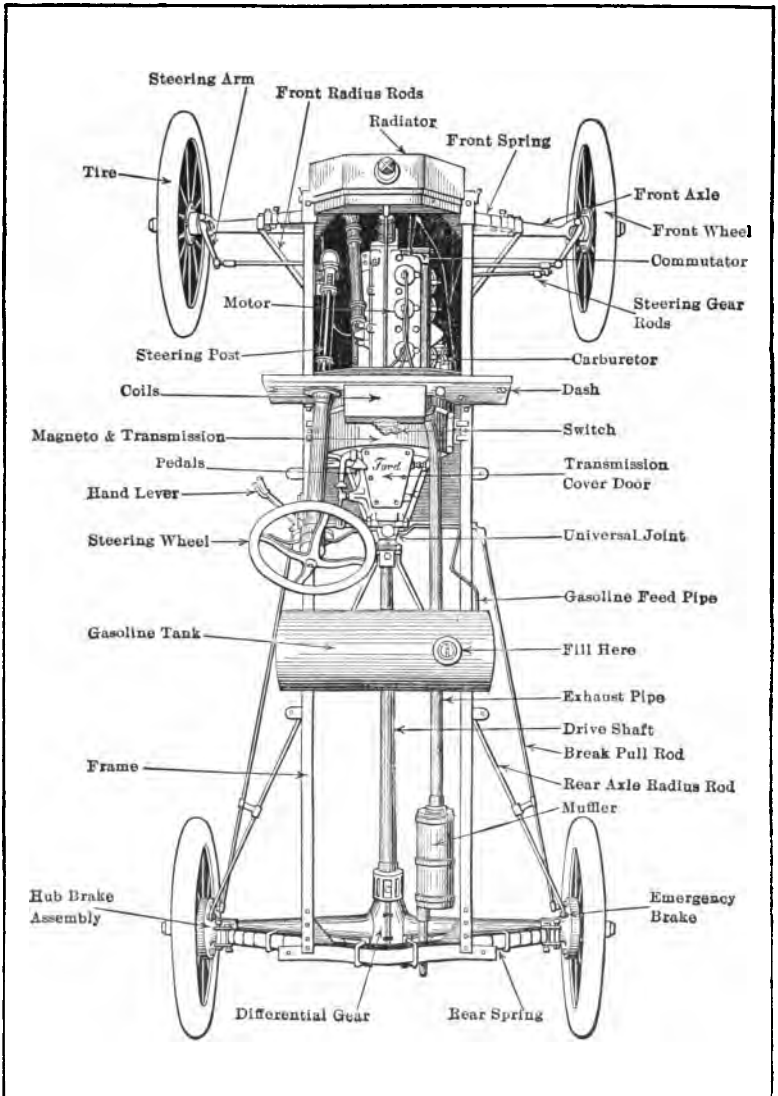


Fig. 3.—Plain View of the Ford Chassis Showing Relative Location of Important Components.

are used in conjunction with the accelerator to vary the rotative speed of the motor and thus regulate the energy produced in proportion to the work to be performed. The emergency brake lever applies a powerful braking effect when it is desired to stop the car quickly and also when one wishes to lock the brakes if the car movement is arrested on a down grade. The change speed lever operates the sliding gearing, which is utilized to produce varying ratios of velocity between the engine shaft and the rear wheel. The steering wheel actuates the mechanism which moves the wheels to the right or left when one wishes to describe the circle, turn a corner, or otherwise deviate from a straight line.

The change speed gear is one of the most important elements of the power transmission system and in connection with the clutch it is much used in operating and controlling the vehicle. The function of the frame has been previously described. The exhaust pipe is employed to convey the inert gases discharged from the motor cylinders to a device known as the muffler, which is designed to reduce the exhaust gas pressure by augmenting the volume and thus diminish the noise made as it issues to the atmosphere. The driving shaft transmits power from the change speed gearset to the bevel gearing in the rear axle. A universal joint is a positive connection which permits a certain degree of movement between two shafts which must be driven at the same speed. One or the other, or both, may move in a lateral or vertical plane to a limited extent without interrupting the drive or cramping the transmission parts. Some cars have one, most 1917 models have two.

The power transmitted by the universally jointed propeller shaft goes to a differential mechanism and driving gearing in the rear axle from which shafts deliver the energy to the traction wheels. All parts are supported by or attached to the frame, made of pressed steel with suitable side members and cross braces held together by rivets. The frame carries springs or yielding members which allow movement of the frame with respect to the axles. The rear wheels are invariably provided with brakes to bring the vehicle to a stop, these being easily operated by the driver. The storage battery carries the current

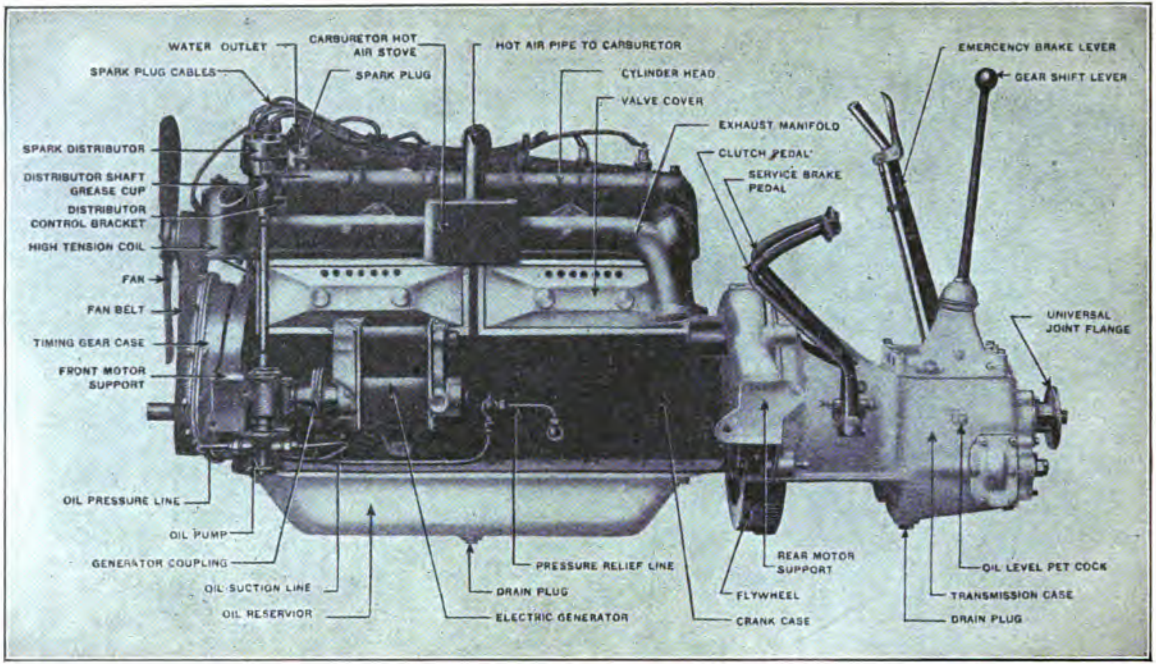


Fig. 4.—Side View of Chalmers Light Six Engine, Showing Arrangement of Power Plant Auxiliaries and Mounting of Gear Box as a Unit With the Engine.

for starting the motor, ignition and lighting the lamps used in night driving. The starting motor turns over the engine crank shaft to get the engine going. The generator supplies the storage battery when the engine is running. The gasoline tank carries the fuel needed to run the engine, this being turned into a gas that will explode in the motor cylinders to produce power by a carburetor.

Gasoline Engine Types.—The gasoline engine may have any number of cylinders, though the conventional types used in automobile propulsion seldom use any but an even number, usually four or six and never more than twelve. At one time single-cylinder motors were very popular. These were used in both the horizontal and vertical types. Power plants of this type were, for the most part, of low power and were patterned largely after stationary gasoline engine practice as far as proportion of parts was concerned. They were heavy and operated at low speed. Such engines are seldom employed at the present time, except in cars of ancient construction, some of which are still in use. Though this type of motor was comparatively slow acting and considerable vibration existed while it was in operation, they were strongly constructed and capable of giving very satisfactory service. Engines of this type were usually installed under the body, the engine cylinder being parallel with the frame side member while the crank shaft was at right angles to it. This permitted a very simple and efficient method of power transmission, as the planetary change speed gearing which was usually carried on the crank shaft extension could be easily coupled to the rear axle by means of a single chain and a pair of sprockets.

The engines of present day automobiles are of the multiple cylinder form because they are more flexible, smoother running and more practical than the simpler types used a decade ago. Six, eight and twelve-cylinder forms are used in many cases. The more cylinders there are, the greater the number of power impulses one obtains to each turn of the rear wheels for a given final drive gear ratio. Few impulses or explosions result in jerky action, more impulses mean steadier power. For instance,

a four-cylinder engine has two explosions each revolution of the crank shaft; a six has three; an eight-cylinder has four, and a twelve-cylinder has six explosions. As the cylinder number is increased, the size can be reduced to secure the same power as obtained with a lesser number of larger cylinders. There is less vibration with small cylinders than with large ones and the working parts are not loaded so much. The power output depends upon the size of the cylinders as well as their number.

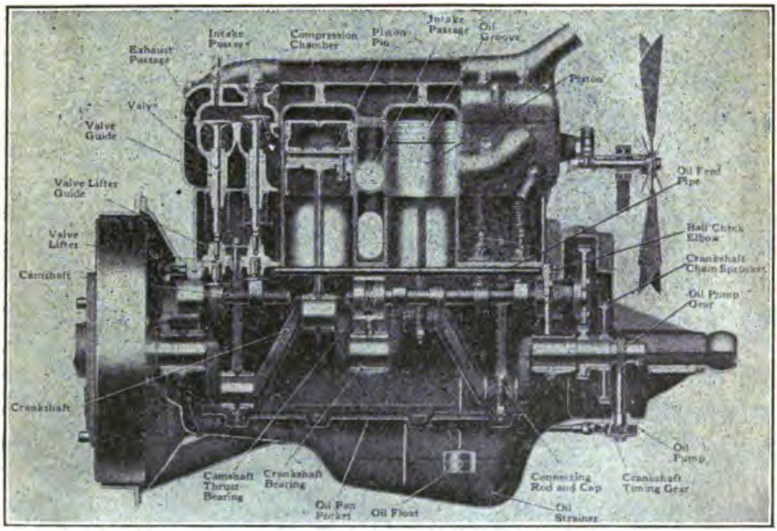


Fig. 5.—Sectional View of Dodge Brothers Four Cylinder Motor, Showing All Important Parts of a Gasoline Automobile Engine.

Many six-cylinder engines have more power than twelve-cylinder forms. The essential parts of an eight or twelve-cylinder engine are no different than in simpler types; there are more of them, that is all. A typical six-cylinder power plant is shown at Fig. 4, while the part sectional view of a four-cylinder at Fig. 5 shows the interior parts which produce the power.

The method of installing the power plant varies but slightly on different types of automobiles, and the majority of cars have the engine placed at the extreme front end of the chassis. In

some types of cars where double-cylinder motors of the horizontal type are used the motor is placed under the seat or body. This type of construction is nearly obsolete at this time, and is found only on early forms of vehicles and one or two commercial cars. The power plant is nearly always combined with the clutch and change speed gearing in such a way to form a unit construction as shown at Fig. 4. This method of joining the parts is widely used at the present time, and is superior to the other common method where the motor and change speed gears are independent units. Each method has advantages. When the gearset and motor are separate the transmission may be removed from the chassis frame without disturbing the power plant and *vice versa.* At the other hand, when the unit construction is employed, it is sometimes difficult to remove one member without taking the entire unit from the frame. The unit construction has the advantage of retaining positive alignment of the gearset with the engine indefinitely. This relation between the parts is obtained when they are first assembled and the alignment cannot be changed by any condition of operation after the unit is installed in the frame. This method of mounting also permits the three-point suspension, which is very desirable, as the power plant is not stressed by frame deformation when going over rough roads.

If one raises the hood at the front of a motor car, one will find a complete engine assembly very much the same as that depicted at Fig. 6, which outlines a popular engine with the various auxiliary parts lettered so that one can obtain an idea of their location relative to each other. Of the external parts shown the carburetor is employed to mix the gasoline used as fuel with a certain amount of air in order to form a gas that can be ignited in the engine cylinders. This explosive mixture is supplied to the cylinders by a conductor known as the inlet pipe. The spark plugs and magneto form part of the ignition outfit. The engine shown is a four-cylinder form and operates on the four-cycle principle.

Automobile Engine Parts.—All internal combustion engines, regardless of type, must have the following parts: Cylinder,

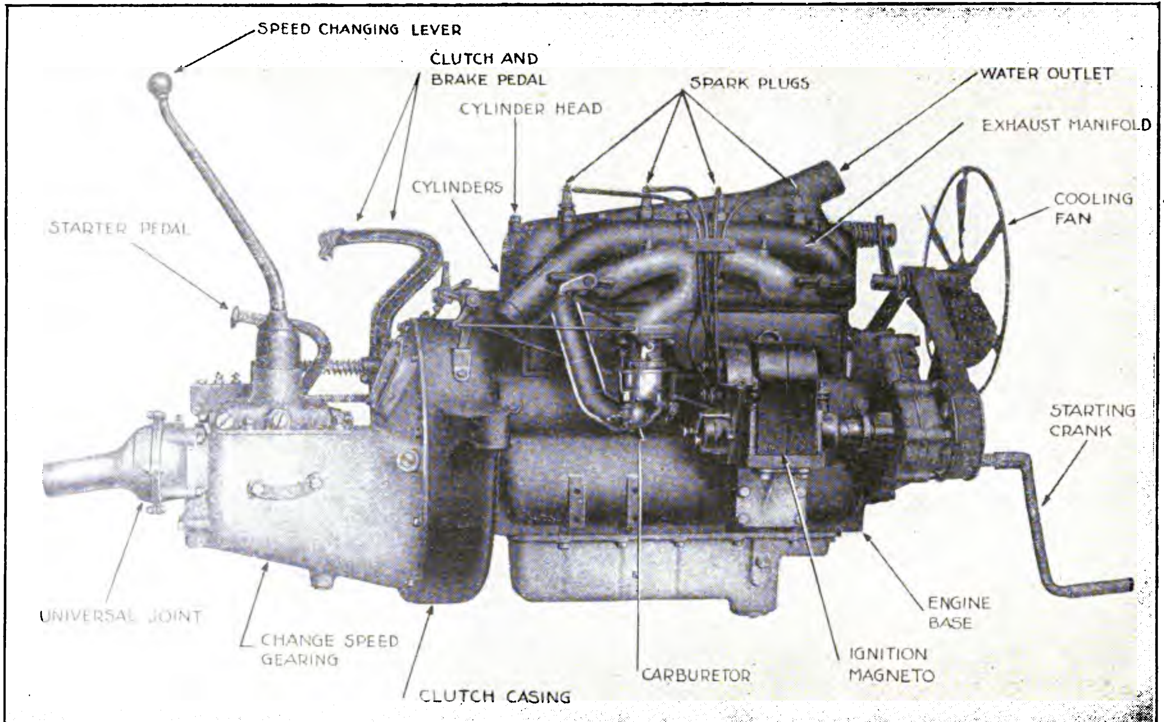


Fig. 6.—The Maxwell Unit Power Plant, Showing Location of Ignition Magneto and Carburetor, as Well as Change Speed Gearing Combined With Engine.

piston, connecting rod, crankshaft, and engine base. In addition to parts previously enumerated, four-cycle engines must have inlet and exhaust valves, valve operating push rods, valve springs for closing the valves, cams to open them and gearing of some form to drive the camshaft from the crankshaft. The cylinder is the portion of the engine in which the gases are confined prior to ignition and which serves as a guide for the piston member which transmits the power of the explosion to the crankshaft. Cylinders are invariably made of cast iron of special mixture because this material withstands the heat better than any other and is easily poured into moulds in a molten condition to form very intricate shapes that would be difficult to produce commercially in any other way. The combustion chamber is at the upper end or closed portion of the cylinder. Cylinders may be cast individually, in pairs, or in blocks of three, four or six.

The piston is a reciprocating cylindrical member that moves in the cylinder and which transforms the power of the explosion to mechanical energy. Pistons are usually made of close grained gray iron of approximately the same mixture as the cylinder iron, though where great lightness is desired, as on aeroplane and high speed automobile motors, steel may be employed or aluminum alloy. A piston is usually provided with a series of grooves in which rings of cast iron are mounted to form a packing. The piston must be a free fit in the cylinder in order that it will not expand unduly when heated and bind. For this reason the packing rings are depended upon to keep the exploding gases from leaking by, and as they have considerable elasticity they conform to the cylinder bore and fit it very closely. As they are narrow they do not have much bearing surface on the cylinder and do not offer undue friction if properly lubricated. The piston rings are usually placed at the top of the piston.

The connecting rod is the member that forms the connecting link between the reciprocating piston and the rotary crankshaft. It describes a rotary movement at its lower end and oscillates at its upper end. Connecting rods are invariably made of steel drop forgings. The crankshaft is the part of the motor which converts the reciprocating motion of the piston to a continuous

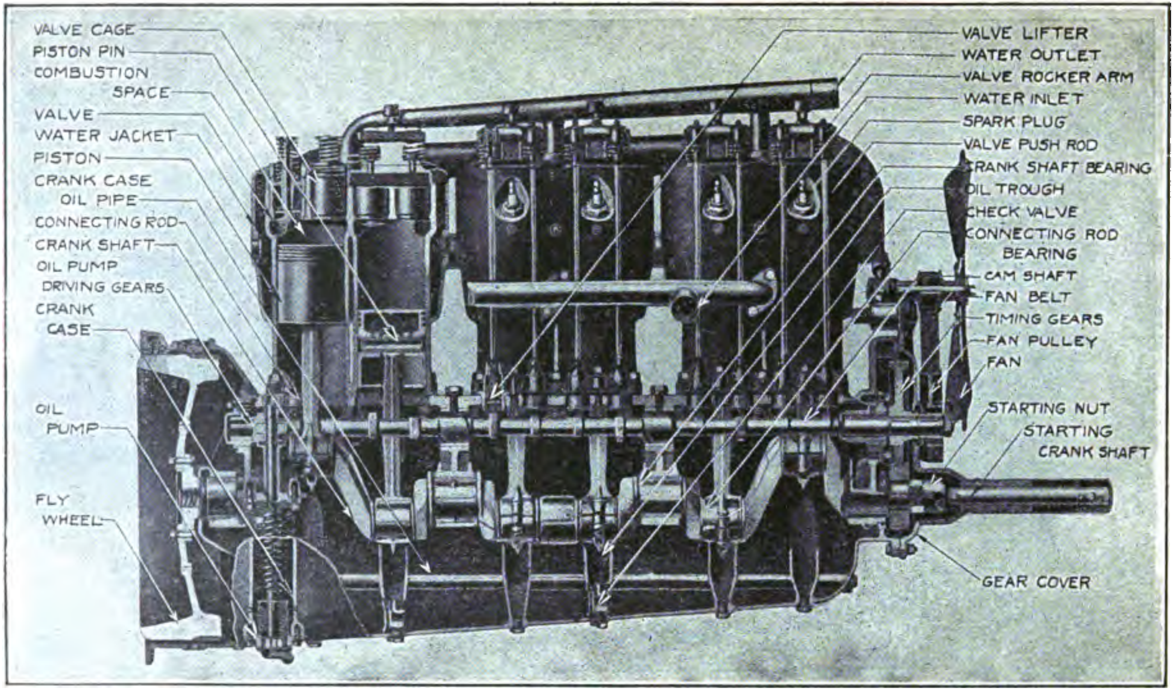


Fig. 7.—Part Sectional View of the Buick Six Cylinder Overhead Valve Motor, Depicting Important Parts.

rotary movement suitable for turning the wheels of the automobile. The crank case is utilized to support the crankshaft and to act as a bed for the engine cylinders. It keeps the working part of the cylinder in perfect alignment with the crankshaft and camshaft carried and protected by the crank case, and at the same time it serves as a carrying or supporting member by which the power plant is attached to the chassis.

Automobile engine crank cases may be made of cast aluminum, cast iron, or bronze castings. The first named material is most generally used on account of its lightness. It has about the same strength as cast iron and weighs but one-third as much. On engines that are manufactured in large quantities, stamped sheet metal, such as steel and aluminum, have been utilized as the lower portion of the crank case. The small auxiliary shaft that carries the valve lifting cams and usually runs parallel with the crankshaft and which is driven by that member is called the camshaft. Some engines have but one camshaft, which carries the cams utilized in operating both inlet and exhaust valves. The "L" type cylinder engine needs but one camshaft, while the power plant provided with "T" head cylinders needs two camshafts, one at each side of the motor. The camshaft of a four-cycle engine is always driven at half the engine speed and always by positive gearing. A cam is a cylinder of metal having a raised portion at one point on its periphery. The difference between inlet and exhaust cams is in the cam profile, as the member intended to lift the exhaust valve has a longer dwell or larger and longer raised portion because the exhaust valve is kept open longer than the inlet member. The manifolds are the built-up members or pipes that convey the fresh gas from the carbureting device to the valve chambers or which convey the inert products of combustion from the exhaust valve chambers to the muffling device. Manifolds are usually attached to cylinders by means of flange couplings bolted to the cylinders or by stirrups or retention bars which hold them securely in place.

The flywheel is a heavy member attached to the crankshaft which has energy stored in its rim as the member revolves, and the momentum of this revolving mass tends to equalize the inter-

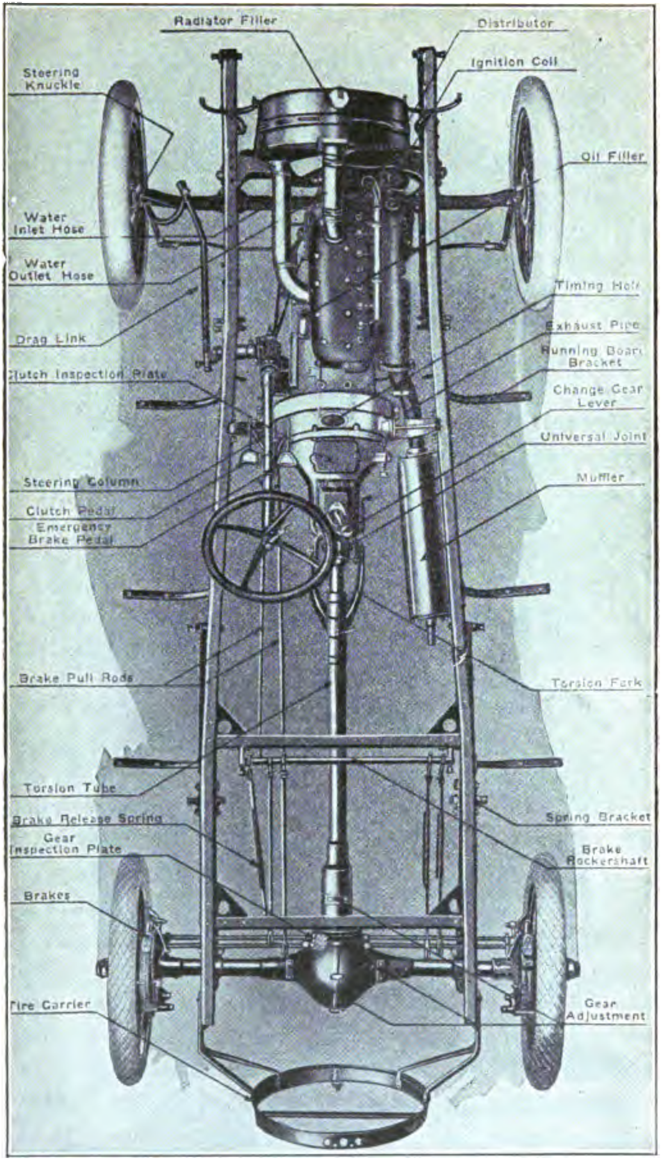


Fig. 8.—Plan View of the Dort Four Cylinder Chassis, Showing Important Parts of the Mechanism and Their Relation to Each Other.

mittent pushes on the piston head produced by the explosion of the gas in the cylinder. If some explosive is placed in the chamber formed by the piston and closed end of the cylinder and exploded, the piston would be the only part that would yield to the pressure which would produce a downward movement. As this is forced down the crankshaft is turned by the connecting rod, and as this part is hinged at both ends it is free to oscillate as the crank turns, and thus the piston may slide back and forth while the crankshaft is rotating or describing a curvilinear path. It is imperative that flywheels be attached firmly to the crankshaft, because any looseness between the flywheel and the shaft will produce a pronounced knocking sound, and the methods of fastening, such as keys or bolts, may be entirely sheared off.

The marks on flywheel rims are placed thereon to assist in timing the valves and ignition spark. The abbreviation E. O. means "Exhaust Opens," while E. C. means "Exhaust Closes." The letters I. O. mean "Inlet Opens," while I. C. means "Inlet Closed." The letter S. indicates the sparking point, while U. C. means "Upper Center," which means that the piston is at the top of its stroke, and L. C. means "Lower Center," which corresponds to the crankshaft position when the piston in the cylinder being timed is at the bottom of its stroke. The numbers in connection with the marks indicate the cylinders in which the functions marked should be taking place.

In addition to the simple elements described it is evident that a gasoline engine must have other parts. The most important of these are the valves, of which there are two to each cylinder. One closes the passage connecting to the gas supply and opens during one stroke of the piston in order to let the explosive gas into the combustion chamber. The other member, or exhaust valve, serves as a cover for the opening through which the burned gases can leave the cylinder after their work is done. The spark plug is a simple device which permits one to produce an electric spark in the cylinder when the piston is at the best point to utilize the pressure which obtains when the compressed gas is fired. The valves of each cylinder open one at a time, the inlet

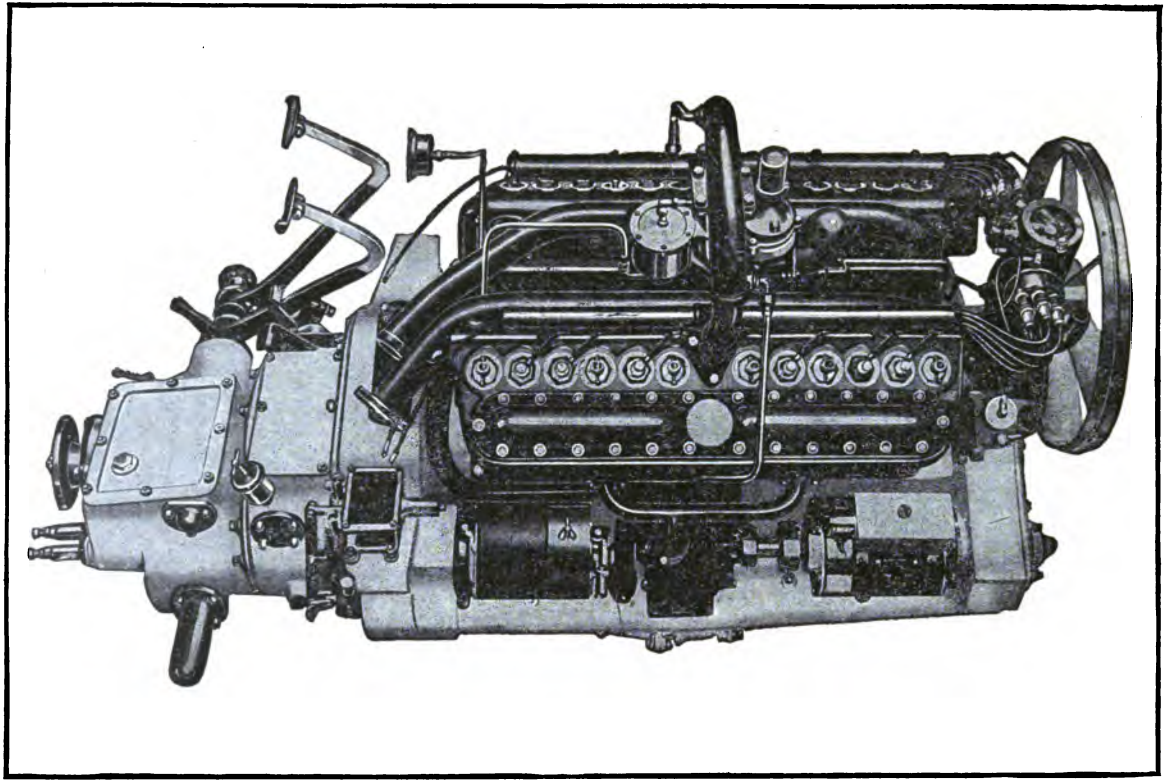


Fig. 9.—The Packard Twelve Cylinder or Twin Six Unit Power Plant Used on All Late Models of This Well-Known Car.

valve being lifted from its seat while the cylinder is filling and the exhaust valve is opened when the cylinder is being cleared. They are normally kept seated by means of compression springs and are raised at the proper time by the cams on the camshaft. The engine shown at Fig. 5 is the Dodge and has all valves on one side of the cylinder. That at Fig. 7 is a six-cylinder Buick engine in which the valves are placed directly in the head, opening into the center of the combustion chamber instead of at one side. The twelve-cylinder engine shown at Fig. 9 is really two six-cylinder engines mounted on a common crank case; similarly the eight-cylinder shown at Fig. 10 is a twin four.

Cooling Systems.—In order to keep the temperature of an automobile engine within bounds and keep the heat down to a point where the lubricating oil will not be destroyed or engine parts warped, the cylinders of the engine must be cooled. Two systems of cooling are possible. The simplest involves flanging the cylinders and passing air currents over them. This is seldom used. The accepted method is to pass water around the cylinders through water jackets cast integral with them. If the greater proportion of the heat units derived by burning the explosive mixture could be utilized in doing useful work the efficiency of the gasoline engine would be greater than that of any other form of power producer. There is a great loss of heat from various causes, among which can be cited the reduction of pressure through cooling the motor and the loss of heat through the exhaust valves when the burned gases are expelled from the cylinder. The loss through the water jacket of the average automobile power plant is over 50% of the total fuel efficiency. This means that more than half of the heat units available for power are absorbed and dissipated by the cooling water. Another 16% is lost through the exhaust valve, and but 33⅓% of the heat units do useful work.

The parts of a forced circulation water cooling system are illustrated at the bottom of Fig. 11. The main parts are a radiator to cool the heated water, a fan to draw air through the radiator and a circulating pump. The water is drawn from the lower header of the radiator by the pump and is forced

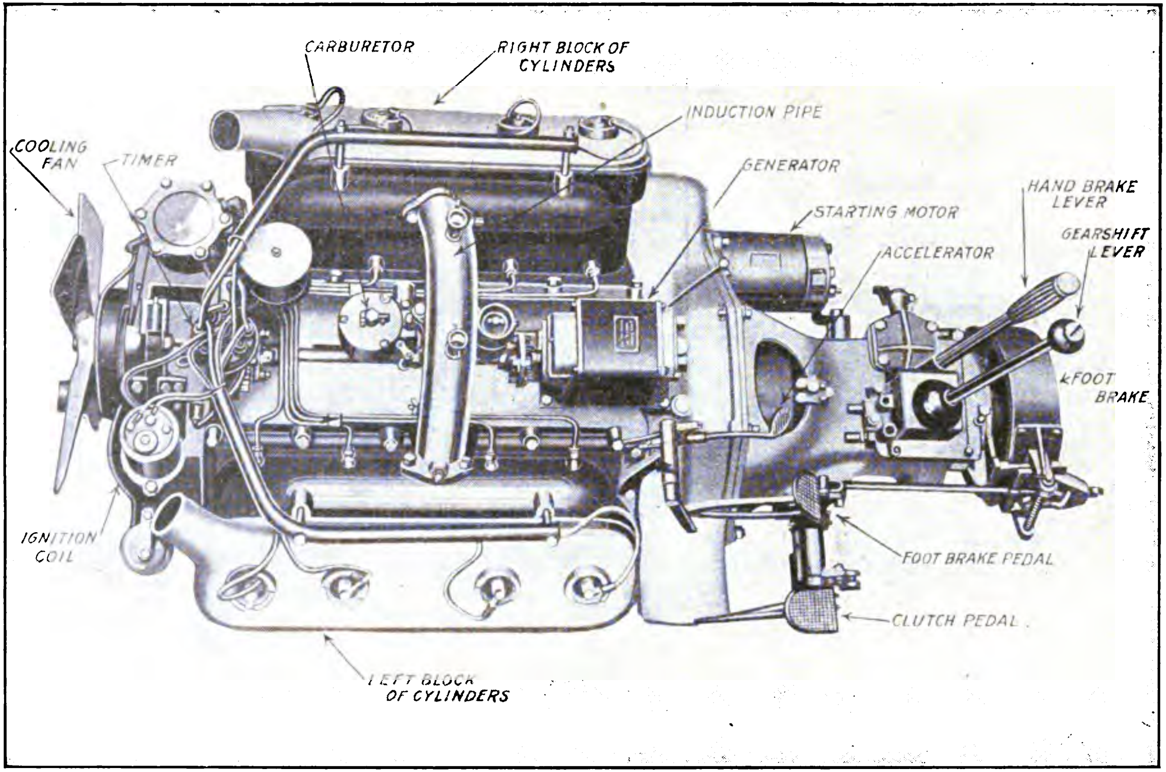


Fig. 10.—Plan View of the Stearns Knight Eight Cylinder Power Plant, Showing Location of Power Plant Auxiliaries.

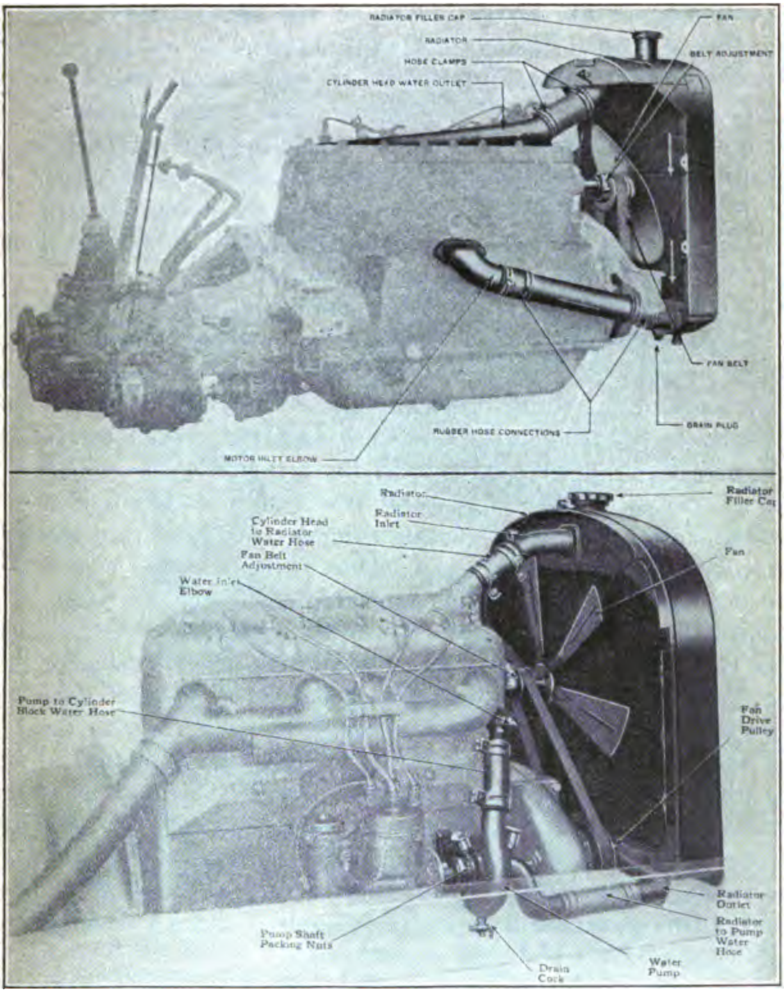


Fig. 11.—Outlining the Two Possible Systems of Water Cooling. At Top, Thermo-Syphon or Natural Flow System of Chalmers, 30 Power Plant. Below It, the Pump Circulation System of the Dodge Brothers Motor Car is Shown.

through a pipe to the lower portion of the water jackets of the cylinder. It becomes heated as it passes around the cylinder walls and combustion chambers and the hot water passes out

of the top of the water jacket to the upper portion of the radiator. Here it is divided in thin streams by the many tubes and directed against comparatively cool metal walls, which abstract the heat from the water. As it becomes cooler it falls to the bottom of the radiator because its weight increases as the temperature becomes lower and also because of the pressure back of it. By the time it reaches the lower tank of the radiator it has been cooled sufficiently so that it may be again passed around the cylinders of the motor.

The cooling system depicted at the top of Fig. 11 is one that has demonstrated its worth conclusively in practice and is somewhat simpler than the forms in which a pump is used to maintain circulation. With this method, the fact that water becomes lighter as its temperature becomes higher is taken advantage of in securing circulation around the cylinders. The top of the water jacket of the cylinders is attached to the center of the radiator, while the pipe leading from the bottom of that member is connected to a motor inlet elbow which supplies cool water to the bottom of the cylinder jacket. With such a system it is imperative that the radiator be carried at such a height that the cool water will flow to the water spaces around the cylinders by gravity. As the water becomes heated by contact with the hot cylinder and combustion chamber walls it rises to the top of the water jackets, flows to the cooler, where enough of the heat is absorbed to cause it to become sensibly greater in weight. As the water becomes cooler it falls to the bottom of the radiator and it is again supplied to the water jacket. The circulation is entirely automatic and continues as long as there is a difference in temperature between the liquid in the water spaces of the engine jacket and that in the cooler.

Carburetion System.—There is no appliance that has more influence upon the efficiency of the internal combustion motor than the carburetor or vaporizer which supplies the explosive gas to the cylinders. It is only in recent years that engineers have realized the importance of using carburetors that are efficient and that are so strongly made that there will be little liability of derangement. As the power obtained from the gas

engine depends upon the explosion of fuel and air mixture in the cylinders, it is evident that if the gas supplied does not have the proper proportions of elements to insure rapid combustion the efficiency of the engine will be low. When a gas engine is used in a stationary installation it is possible to use ordinary illuminating or natural gas for fuel, but when this

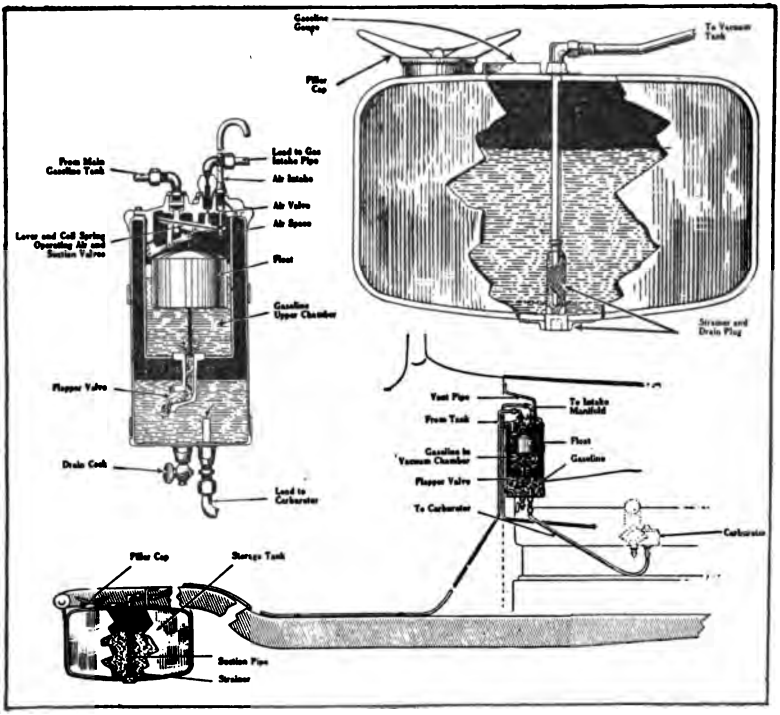


Fig. 12.—The Fuel System of the Overland Model 85 Cars is Typical of Standard 1917 Practice. The Interior Construction of the Vacuum Tank and the Main Fuel Container are Shown in Detail.

prime mover is applied to automobile or marine service it is evident that considerable difficulty would be experienced in carrying enough compressed coal gas to supply the engine for even a very short trip. Fortunately, the development of the internal combustion motor was not delayed by the lack of suitable fuel.

Engineers were familiar with the properties of certain liquids which gave off vapors that could be mixed with air to form an explosive gas which burned very well in engine cylinders. A small quantity of such liquids would suffice for a very satisfactory period of operation. The problem to be solved before these liquids could be applied in a practical manner was to evolve suitable apparatus for vaporizing them without waste. Among the liquids that can be combined with air and burned, gasoline is the most common and is the fuel utilized by the majority of internal combustion engines employed in self-propelled conveyances. The problem of gasoline storage and method of supplying the carburetor is one that is determined solely by design of the car. While the object of designers should be to supply the fuel to the carburetor by as simple means as possible, the fuel supply system of some cars is quite complex. The first point to consider is the location of the gasoline tank. This depends upon the amount of fuel needed and the space available in the car.

A very simple and compact fuel supply system is where the tank is placed in the motor compartment or under the cowl. The power plant in such cars is usually an engine of low power and correspondingly low fuel consumption. As it does not require much gasoline to run a small engine one can obtain a satisfactory touring radius on one filling of a comparatively small tank. When the fuel container is suspended near the dashboard and placed immediately back of and above the engine cylinders, the carburetor may be joined to the tank by a short piece of copper tubing. This is the simplest possible form of fuel supply system.

The old method of supplying gasoline to the carburetor when the tank was carried so low that the fuel would not flow by its own weight was to pump air or gas into the supply tank and displace the gasoline by its pressure, but now a vacuum feed tank is used. From the main supply tank the fuel goes to a small auxiliary tank carried on the dash of the power plant compartment. A short pipe connects this small container with the carburetor, and as this auxiliary tank is higher than the mixing device the fuel will flow to the carburetor by gravity.

If gasoline under pressure was fed directly to the carburetor it might result in an oversupply of fuel because there might exist pressure enough to force the gasoline into the float chamber because the shut-off needle valve would not seat positively. The auxiliary tank, which draws fuel by engine suction from a tank at the rear, is provided with an automatic cut-off mechanism, which interrupts the fuel supply when the small container is properly filled. The various parts of such a fuel system are shown at Fig. 12.

What a Carburetor Should Do.—While it is apparent that the chief function of a carburetor device is to mix gasoline vapors with air to secure mixtures that will burn, there are a number of factors which must be considered before describing the principles of vaporizing devices. Almost any device which permits a current of air to pass over or through a volatile liquid fuel will produce a gas which will explode when compressed and ignited in the motor cylinder. Modern carburetors are not only called upon to supply certain quantities of gas, but these must deliver a mixture to the cylinders that is accurately proportioned and which will be of proper composition at all engine speeds. Flexible control of the engine is sought by varying the engine speed by regulating the supply of gas to the cylinders. The power plant should run from its lowest to its highest speed without any irregularity in torque, i. e., the acceleration should be gradual rather than spasmodic.

A carburetor consists of a float or feed chamber which maintains a constant height of gasoline in a spray nozzle carried in a mixing compartment where gasoline is sprayed into the entering air stream drawn into the engine cylinders by the suction or pumping effect of the pistons as they descend on their suction strokes. The gasoline vapor and air mix to form a gas which can be ignited by an electric spark when it is properly compressed in the cylinders, this gas entering through the inlet valves and intake manifold which joins the vaporizing device to the cylinders. Adjustment means are usually provided on the carburetor to vary the mixture proportions by changing either the gasoline supply or air flow.

2

Ignition Methods.—The other essential auxiliary group of the automobile power plant, and one absolutely necessary to insure engine action, is the ignition system, or the method employed of kindling the compressed gas in the cylinder to produce an explosion and useful power. The ignition system has been fully as well developed as other parts of the automobile, and at the present time practically all ignition systems follow principles which have become standard through wide acceptance. The essential elements of any ignition system are: First, a simple and practicable method of current production; second, suitable timing apparatus to cause the spark to occur at the right point in the cycle of engine action; third, suitable wiring and other apparatus to convey the current produced by the generator to the sparking member in the cylinder. Dry batteries are the simplest method of current generation, but storage batteries are mostly used at the present time.

Two distinct types of mechanical generators are in common use and, while their principles of action are practically the same, they differ somewhat in construction and application. The forms first used to succeed the battery were modifications of the larger dynamo electric machines used for delivering current for power and lighting. Later developments resulted in the simplification of the dynamo by which it was made lighter and more efficient, and the magneto igniter is the form furnished on some modern power plants. A dynamo uses electro-magnets to produce a magnetic field for the armature to revolve in and is necessarily somewhat heavier and larger than a magneto of equal capacity because the field in the latter instrument is produced by permanent magnets. An important advantage in using the magneto form of construction is that the weight of the windings is saved because the permanent magnets retain their magnetism and do not require the continual energizing that an electro-magnet demands.

The dynamo construction is superior where a continual drain is made upon the apparatus, as in modern lighting and electric starting systems, because if a magneto is used continuously the magnets are liable to lose some of their strength, and as the

magnetic field existing between the pole pieces decreases in value the amount of current delivered by the apparatus diminishes in direct proportion. When electro-magnets are used the constant flow of electrical energy through the windings keeps them energized to the proper point, and, as current is continuously supplied, the strength of the magnetic field remains constant. The dynamo form of generator is utilized where currents of considerable value are needed, such as in electric lighting systems now so widely used on automobiles.

When the device is depended upon only to furnish ignition current the magneto is preferred by some engineers because it is simpler and lighter than the dynamo, and also because it may be made in such form that it will comprise a complete ignition system in itself. When a dynamo is utilized the conditions are just the same, as far as necessary auxiliary apparatus is concerned, as though batteries were used and one merely substitutes a mechanical generator in place of the chemical cells. The same auxiliary apparatus necessary in one case is employed in the other as well. Anyone familiar with the basic principles of internal combustion engine action will recognize the need of incorporating some device in the ignition system which will insure that the igniting spark will occur only in the cylinder that is ready to be fired and at the right time in the cycle of operations. There is a certain definite point at which the spark must take place, this having been determined to be at the end of the compression up stroke, at which time the gas has been properly compacted and the piston is about to start returning to the bottom of the cylinder again. Timers or distributors are a form of switch designed so that hundreds of positive contacts which are necessary to close and open the ignition circuit may be made per minute without failure.

When the device is employed to open and close a low-tension circuit it is known as a commutator or timer, and when used in connection with current of high voltage they are called secondary distributors. Certain constructional details make one form different from the other and while they perform the same functions they vary in design. Such distributing devices are

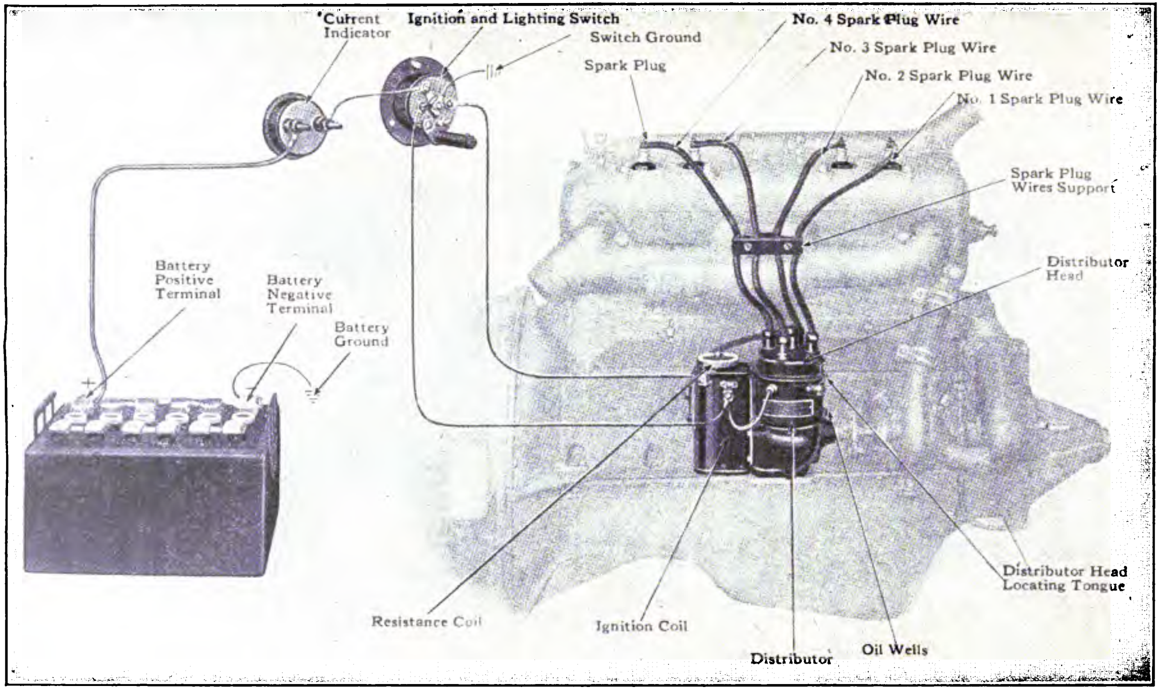


Fig. 13.—The Battery Ignition System of the Dodge Brothers Motor Car is Typical of Present Day Practice.

always driven by positive gearing from the engine and are timed so that the sparks will occur in the cylinders at just the proper ignition time. The usual construction is to use a fixed insulated case which carries one or more contact members disposed around its periphery and a central interior revolving member or cam which contacts with the points on the body of the device to close any desired circuit. The location of a device of this character is clearly shown in Fig. 13, which also shows the other parts of the ignition system.

The current obtained from the dry or storage battery or low-tension dynamo or magneto is not sufficiently powerful to leap the gap which exists between the points of the spark plug in the cylinder unless it is transformed to a current having a higher voltage. The air gap between the points of the spark plug has a resistance which requires several thousand volts pressure to overcome, and as a battery will only deliver six to eight volts, it will be evident that, unless the current value is increased, it could not produce a spark between the plug electrodes. The low voltage current is transformed to one of higher potential by means of a device known as the induction coil, plainly shown in Fig. 13. The current from the battery is passed through a primary coil in this device and is composed of a number of layers of coarse wire. This induces a higher voltage current in the secondary coil wound around it and composed of many turns of very fine wire. With the high tension system of ignition the spark is produced by a current of high voltage jumping between two spark plug points, which break the complete circuit that would exist otherwise in the secondary coil and its external connections. The spark plug is in a simple device which consists of two terminal electrodes carried in a suitable shell member, which is screwed into the cylinder. The secondary wires from the coil are attached to terminals at the top of a central electrode member which is supported in a bushing of some form of insulating material. Some employ a molded porcelain as an insulator, while others use a bushing of mica. The insulating bushing and electrode are housed in a steel body, which is provided with a screw thread at the bottom, by which it is screwed

into the combustion chamber. The current entering at the top of the plug cannot reach the ground, which is represented by the metal portion of the engine, until it has traversed the full length of the central electrode and overcome the resistance of the gap between it and the terminal point on the shell. All wiring of a modern battery ignition system is shown at Fig. 13.

The magneto is a simple form of dynamo and a mechanical

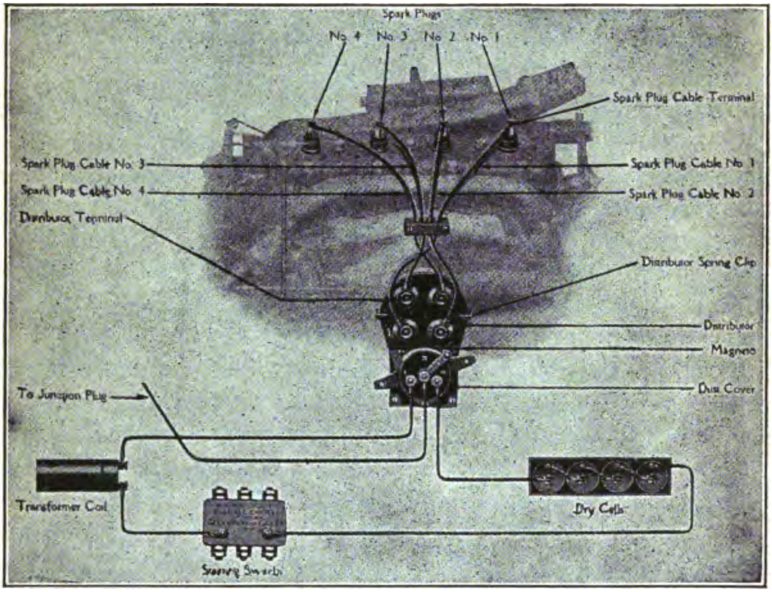


Fig. 14.—The Dual Magneto Ignition System Used on Maxwell Automobiles.

generator of electricity in which permanent magnets are used to produce the magnetic field and between which the armature revolves. The permanent magnets are called "field magnets" and at their ends are provided with cast iron shoes which form the walls of the armature tunnel and which are known as pole pieces. A magneto consists of two compound horse shoe magnets attached to the pole pieces which collect and concentrate the magnetism upon the armature. The armature is shuttle-shaped

and carries a double winding of wire which consists of two coils, one of coarse, the other of fine conductor. The armature is attached to end pieces which carry shafts and the whole assembly revolves on annular ball bearings. An ebonite or hard rubber spool is carried at one end while the condenser is housed at the other. The make-and-break mechanism is partly carried by an oscillating casing and the revolving member is turned from the armature shaft. The current generated in the armature coils is delivered to a metal ring on the ebonite spool, from which it is taken by a carbon brush and delivered directly to the spark plugs. Every time the contact points in the make-and-break device become separated, a current of high potential passes through one of the wires attached to the spark plugs and produces a spark between its points. The magneto is the simplest and most practical form of ignition appliance, as it is self-contained and includes the current generator and the timing device in one unit. In the one-cylinder form all connections are made inside of the device and but one wire leading to the spark plug is necessary to form the external circuit. A magneto employed for multiple-cylinder ignition is not much more complicated than that used for single-cylinder service, the only difference being that a different form of cam is provided in the breaker box and that a secondary distributor is added to commutate the current to the plugs in the various cylinders. The distributor consists of a block of insulating material fixed to the magnets which carries as many segments as there are cylinders to be fired. A central distributing arm or segment is driven from the armature shaft by means of gearing and is employed to distribute the high-tension current to segments connected to the spark plugs in the cylinders by flexible wire conductors. A typical magneto ignition system such as used on Maxwell cars is shown at Fig. 14.

How Engine Is Lubricated.—The importance of minimizing friction at the various bearing surfaces of machines to secure mechanical efficiency is fully recognized by all mechanics, and proper lubricity of all parts of the mechanism is a very essential factor upon which the durability and successful operation of the

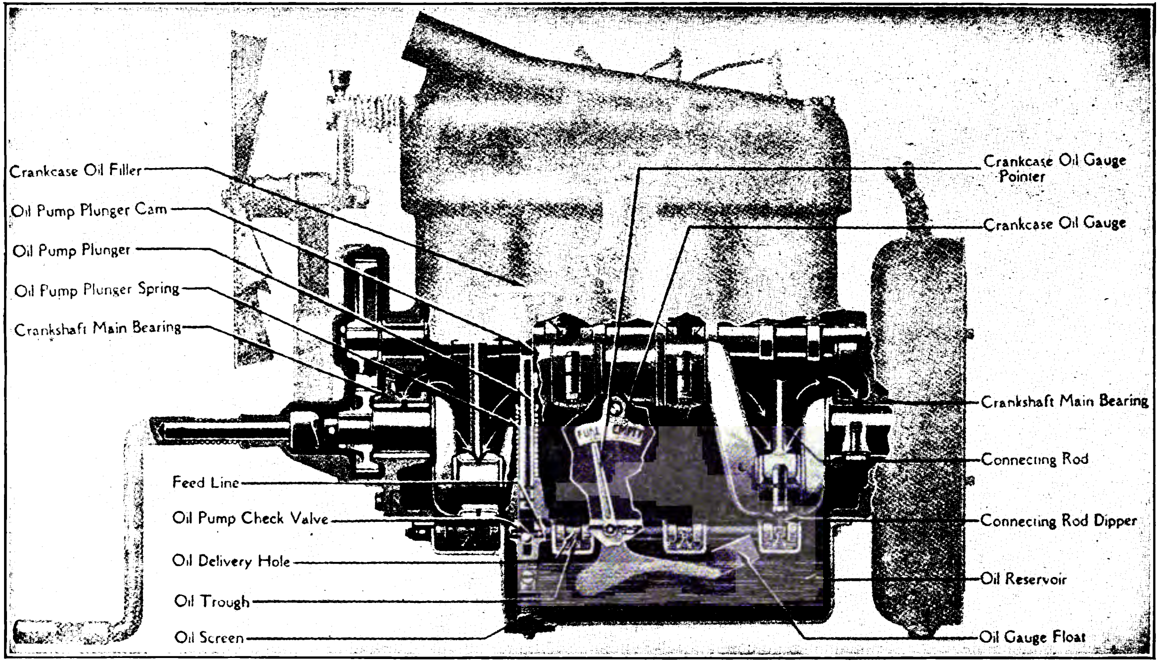


Fig. 15.—Sectional View of Crank Case of Maxwell Four Cylinder Engine, Showing Typical Constant Level Splash System of Lubrication.

motor car power plant depends. All of the moving members of the engine which are in contact with other portions, whether the motion is continuous or intermittent, of high or low velocity, or of rectilinear or continued rotary nature, should be provided with an adequate supply of oil. No other assemblage of mechanism is operated under conditions which are so much to its disadvantage as the motor car engine, and the modern tendency is toward a simplification of oiling methods so that the supply will be ample and automatically applied to the points needing it.

In all machinery in motion the members which are in contact have a tendency to stick to each other and the very minute projections which exist on even the smoothest of surfaces would have a tendency to cling or adhere to each other if the surfaces were not kept apart by some elastic and unctuous substance. This will flow or spread out over the surfaces and smooth out the inequalities existing which tend to produce heat and retard motion of the pieces relative to each other. The method of supplying the lubricant will depend largely upon the nature of the part to be oiled as well as the character of the oily medium.

The various internal parts of the gasoline engine demand continual lubrication and means must be provided which will insure positive supply of lubricant in measured quantities for more or less extended periods. Engine lubricators should be positive in action and not liable to be affected by varying weather conditions. The lubricant should not be supplied in excess and in some systems it is desirable that the feeds be adjusted as desired and independently of each other. Any oiling device should be as nearly automatic in action as possible and the modern types should require but little further attention from the motorist than to keep a proper amount of lubricant in the container. The oil feed to the moving parts should start as soon as the engine begins to turn and the supply be interrupted when the mechanism stops. The only system which combines all the desirable features is that which includes a mechanical drive from the source of power. Lubricators may be divided into two classes, those which depend upon natural phenomena such as attraction of gravity or displacement of air pressure

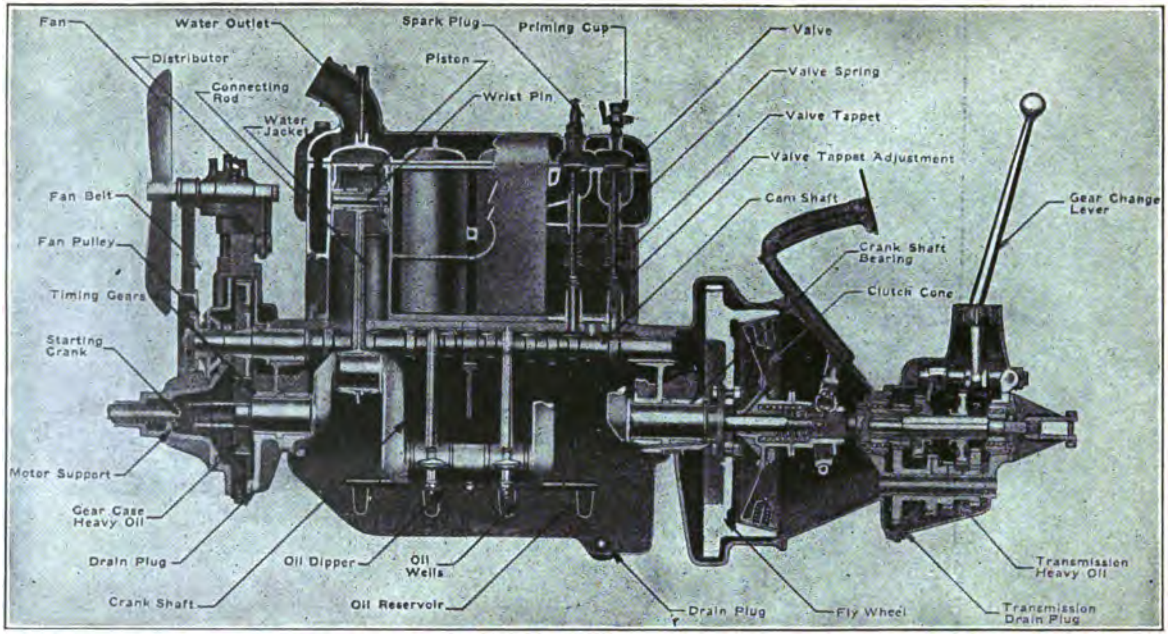


Fig. 16.—Part Sectional View of Dort Four Cylinder Unit Power Plant, Showing Important Parts of Motor, Clutch and Change Speed Gearing.

and others which are worked by mechanical means and which deliver the oil in measured quantities by positively driven pumps. The former are never used now on automobile engines, as reliability is essential without calling for constant attention.

Oil Supply by Constant Level Splash System.—The splash system of lubrication that depends on the connecting rod to distribute the lubricant is one of the most successful and simplest forms if some means of maintaining a constant level is provided. If too much oil is supplied the surplus will work past the piston rings and into the combustion chamber, where it will burn and cause carbon deposits. Too much oil will also cause an engine to smoke and an excess of lubricating oil is usually manifested by a bluish white smoke coming from the exhaust pipe. A good method of maintaining a constant level of oil for the successful application of the splash system is shown at Fig. 15. The engine base casting has a separate chamber attached to it which serves as an oil container and which is below the level of oil in the crank case. The lubricant is drawn from the sump or oil container by means of a positive oil pump which discharges directly into the troughs under each connecting rod in the engine base. The level is maintained by an overflow which allows all excess lubricant to flow back into the oil container at the bottom of the engine base. Before passing into the pump again the oil is strained or filtered by a screen of wire gauze and all foreign matter removed. Owing to the rapid circulation of oil it may be used over and over again for quite a period of time. New oil is introduced directly into the crank case by a breather pipe and the amount available is indicated by a simple gauge.

Power Transmission Parts.—A typical power transmission group such as employed in the Dort gasoline automobile is depicted in Fig. 16. In this the power is applied to the crankshaft of the motor and from thence it is delivered to the motor flywheel which forms the female member of a friction clutch. The male member of the clutch is coupled to the change speed gearing and this in turn is joined to the driving pinion in the rear axle by a length of shaft not shown in the illustration.

The driving pinion delivers its power to a bevel driving gear which is carried by the differential in the rear axle housing. From the differential gear independent shafts or axles drive the rear wheel hubs.

The function of the clutch is to permit the engine to be run independently of the transmission gearing when desired. The engine can drive the car only when one of the sets of gears in the gearset and the clutch are engaged simultaneously. For example, if the clutch is out or released, even if the gears were in mesh in the change speed device, the rear wheels would not be turned until the clutch cone was allowed to engage the female member formed in the flywheel rim. At the other hand, when the parts are as shown with the clutch in engagement and the speed gears out of mesh the engine crankshaft will revolve without turning the rear wheels.

The most important requirement in considering clutch forms is that such devices be capable of transmitting the maximum power of the engines to which they are fitted without any power loss due to slipping. A clutch must be easy to operate and but little exertion should be required of the operator. When the clutch takes hold, the engine power should be transmitted to the gearset and driving means in a gradual and uniform manner, or the resulting shock may seriously injure the mechanism. When released it is imperative that the two portions of the clutch disengage positively so that there will be no continued rotation of the parts after the clutch is disengaged.

The design should be carefully considered with a view of providing as much friction surface as possible to prevent excessive slipping and loss of power. It is very desirable to have a clutch that will be absolutely silent whether engaged or disengaged. If the clutch parts are located in an accessible manner it may be easily removed for inspection, cleaning or repairs. It is desirable that some adjustment be provided, so a certain amount of wear can be compensated for without expensive replacement. A simple, substantial design with but few operating parts as illustrated is more to be desired than a complex device which may have a few minor advantages, but which is

more likely to cause trouble. The friction clutch in its various efficient types is the one that more nearly realizes the requirements of the ideal clutch.

How Sliding Gearsets Operate.—The majority of change speed gearsets which have been generally fitted to automobile service are sliding gear arrangements. In the selective system it is possible to go into any one of the speeds or gear ratios desired without passing into other speeds and with but a limited movement of the shifting members. The sliding gear system was one of the first to receive general application in early forms of motor vehicles and in its primitive condition it was but a modification of the back gearing used on certain classes of machine tools such as lathes, drill presses, etc. One of the advantages of this type when compared to other gear transmissions, such as the planetary, is that it is possible to provide a greater number of speed changes and obtain a higher driving efficiency when on the lower ratios because but two pairs of gears are in mesh.

The usual number of gear ratios provided is three forward speeds and one reverse motion. On some of the heavier touring cars four forward speeds are provided and when this is done engineers differ as to whether the direct drive should be on the third ratio and the fourth speed obtained by gearing up and having the driving shaft revolve faster than the main shaft of the engine or have the fourth speed a direct drive, the crankshaft and the driving shaft turn at the same speed. Those who favor the former method contend that as most of the regular driving is done at a medium rather than at an extreme high speed the direct drive on the third is preferable to a direct drive on the highest ratio. If the highest speed was obtained by a direct drive the natural tendency of the motorist would be to use this most, but there would be many conditions where the ratio would be too high and one of the lower gears would have to be used. If the direct drive was obtained in the third ratio this would be employed the greater part of the time, and as there would be less wear on the gearing with the direct drive engaged it would be preferable to use this as much as possible.

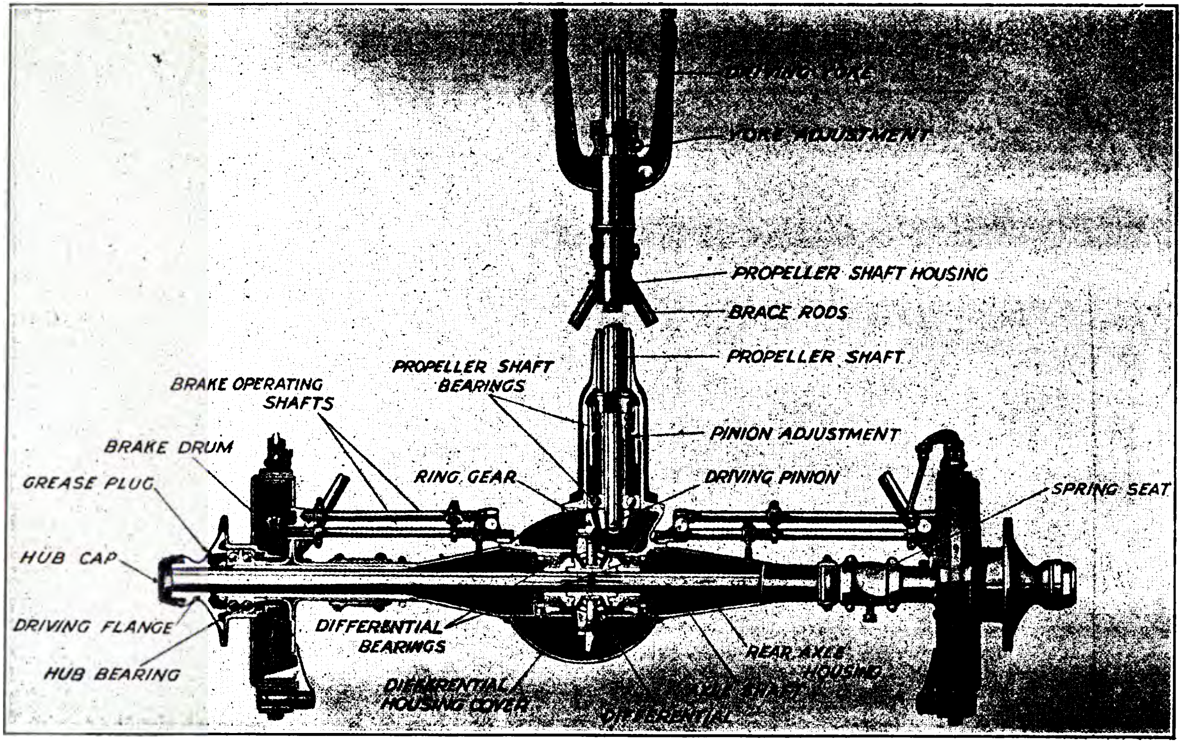


Fig. 17.—Sectional View, Showing Construction of Buick Rear Axle.

The operation is extremely simple. The gears on the counter-shaft are not shifted as they are firmly secured thereto. The sliding members are carried on the main shaft and can engage gears of varying diameter on the lay shaft, the relation between the diameter of the gears engaged determining the gear ratio.

Frame Parts.—Among the parts of the motor car that may be considered closely related to the frame are the side members, cross pieces and braces. It is necessary to have supporting irons by which the mud guards are carried over the front and rear wheels and also to have step hangers to which the running boards are attached. Mud guard supporting irons are usually bolted to the frame or fit into suitable sockets so they may be easily removed. As there is no occasion for removing the running board supporting irons, it is common practice to rivet these to the frame side members. Barring an accident the frame of a car is not likely to be damaged, and in order to prevent loosening of this essential part of the automobile chassis all of the members comprising the frame form a permanent assembly because they are riveted together. The springs by which the weight of the car is carried and which promote easy riding are considered as frame parts. Springs of many forms have been used in automobiles, but the practice has become standardized at the present time to the use of laminated leaf springs in their various forms. Semi-elliptic springs are the most popular for suspending the front end of the car and cantilever springs seem to be the most popular equipment for rear end of 1917 cars. A number of cars use the three-quarter elliptic spring, and the employment of other types, such as full elliptic, platform and transverse springs, is so rare as to be unconventional design. The frame also supports the steering gear and in some cases the clutch and brake pedal assembly and the change speed gear controlling levers when mounted independently of the power plant. In some types of cars radius and torque rods are used to keep the axles in proper relation to the frame. This construction is being rapidly succeeded by the simpler form in which the rear springs are used to keep the axle in its proper relation to the frame, to take the push of the drive and to resist

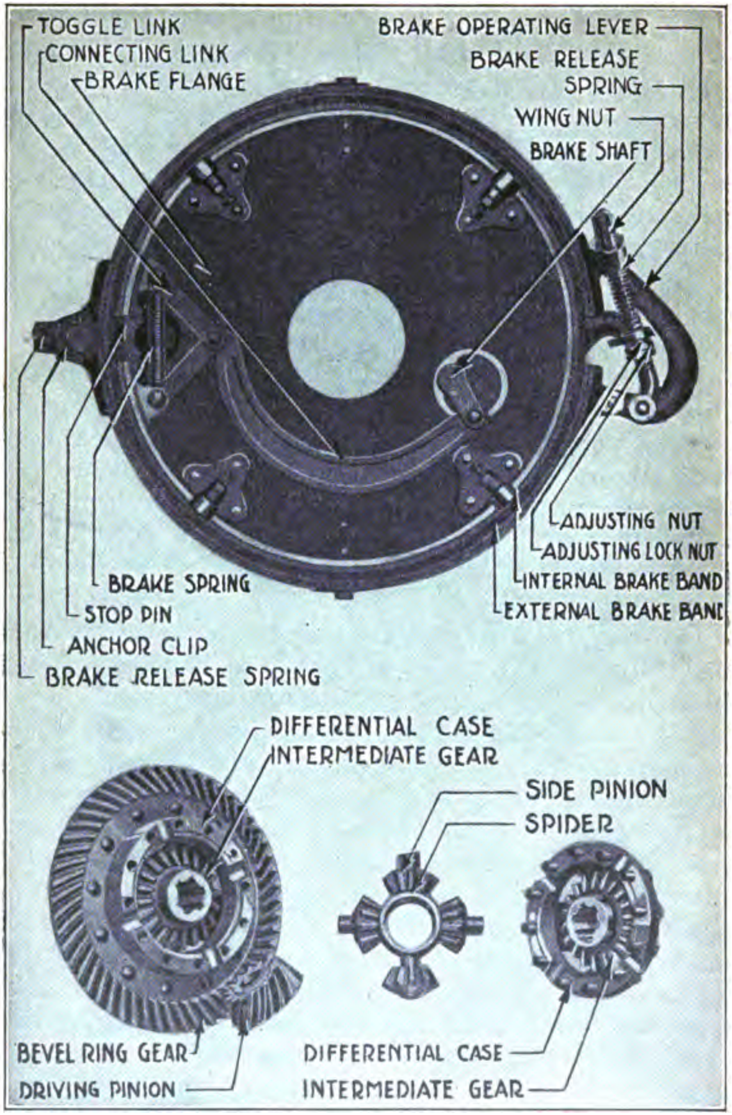


Fig. 18.—At Top, Brake Assembly of Buick Automobile, Showing Relation of Internal Expanding and External Contracting Band Brakes. At Bottom, the Spiral Bevel Driving Gears and Differential Parts are Shown.

the turning action of the axle when the wheels are turning to drive the car or when the brakes are applied. A typical rear end of an automobile frame is shown at Fig. 20.

Rear Axles and Brakes.—Rear axles have been made in many forms, but the live axle is a type generally used on modern automobiles. This is called a live axle because the non-rotatable axle housing contains moving parts, as will be seen by reference to Fig. 17. This axle is termed a one bearing full floating con-

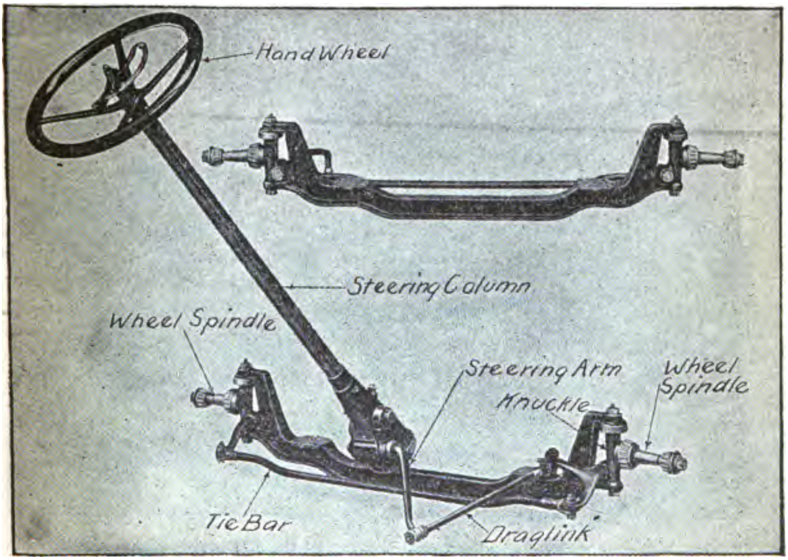


Fig. 19.—Conventional Automobile Steering System.

struction because only one bearing is used in each rear wheel. The power of the engine goes through a clutch and from there to change speed gearing as previously explained. From the gear box the drive is by a propeller shaft, which in the axle illustrated is housed in a torque tube and carries at its lower end a beveled pinion which meshes with a large bevel or ring gear attached to the differential mechanism. From the differential, axle shafts extend to each rear wheel and it is through these

members that the engine power is transmitted to the wheel hubs. In order to eliminate friction as much as possible, all rotating shafts are carried by ball bearings because these members carry heavy loads with very little loss of power.

The differential mechanism which is illustrated at Fig. 18 is a very important part of a live rear axle. Its function is to permit one wheel to turn faster or slower than the other when rounding curves. It is evident that as the car turns a corner

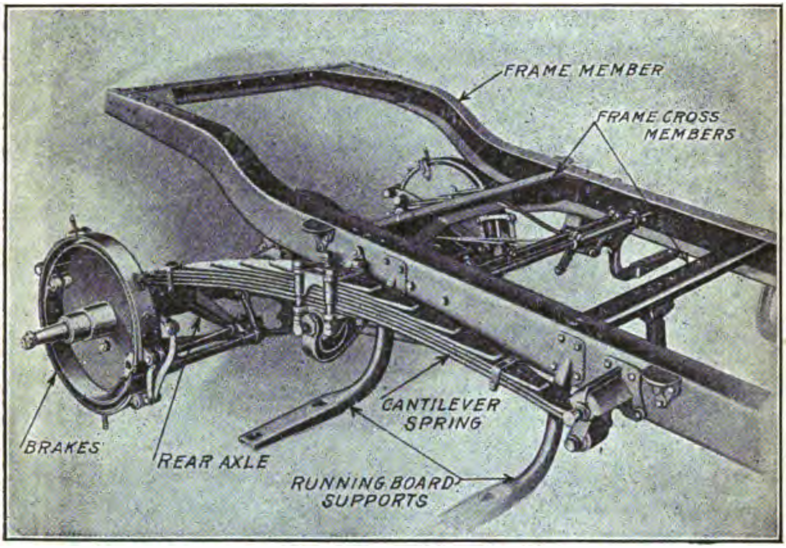


Fig. 20.—Rear Portion of Typical Automobile Chassis Frame, Showing Location of Rear Axle and Cantilever Spring Suspension.

the inner wheel is describing a smaller circle than the outer one and therefore should not turn as fast. If the two wheels were joined rigidly together by a solid or one-piece axle member they would have to turn at the same speed. Whenever a corner was turned, the inner wheel would have to slip considerably which would cause tire wear. The differential mechanism is an assembly of bevel gears on most cars and is placed at the center of the axle and between the two rear wheels. Independent wheel driving shafts are used, each one going to an independent differ-

ential gear, though these are meshed with small bevel pinions which cause them to turn in the proper relation. When the vehicle is on a straight path and the resistance to the movement of each wheel is approximately the same, the differential mechanism revolves as a unit, no relative movement of the internal gearing takes place and both wheels are driven at the same speed. As soon as the resistance to wheel rotation becomes unequal the wheel that has the greatest resistance tends to remain stationary, the wheel that has the least resistance revolves.

Another important part of the car control system that is usually incorporated in the rear construction are the brakes. These act on drums attached to the rear wheels and usually two distinct braking effects are used on each brake drum. The brake assembly shown at the top of Fig. 18 is typical of standard practice in this regard. The external brake is a steel band lined with heat resisting asbestos fabric. It closes around the brake drum to retard its motion. The internal brake consists of a band also faced with frictional material which is expanded or spread out by toggle leverage so that it exerts a retarding influence against the inside of the drum. The external brakes are usually operated by a foot pedal placed close to the clutch pedal, while the internal brakes are actuated by rods connected to the hand lever. Adjustment means are provided to compensate for wear as the brakes are used.

How Automobiles Are Steered.—The problem of steering the motor car is a somewhat different one than that of directing a horse-drawn vehicle, because in the animal-drawn conveyance the shafts which are attached to the front axle are used to turn the vehicle as well as to pull it along. The front axle is usually pivoted at a central point and turns on a fifth wheel arrangement. When it is desired to turn in either direction the animal is guided by the reins and the axle is turned at an angle to the body sufficient to allow the vehicle to describe a curve. In most motor vehicles the propulsive force is applied to the rear wheels and the structure is pushed from behind instead of being pulled, as is the case with a horse-drawn conveyance. Obviously, it

would not be practical to turn the entire axle under the car, because if it described a too acute angle when the car was driven at high speed it would be extremely difficult to control the vehicle.

This was very ingeniously overcome by an engineer named Ackerman, who devised the pivoted axle which is commonly accepted as the proper method of steering automobiles. This consists of a fixed axle member, as shown at Fig. 19, attached to a frame by suitable springs or other means in such a way that it can move only in a vertical direction under the influence of road irregularities. The wheels are mounted on spindles carried in a yoke at each end of the axle, and when it is desired to turn an automobile only the wheels are turned instead of moving the entire axle assembly as is the case in a horse-drawn vehicle. In order to actuate the steering knuckles, suitable mechanism that will be easily operated must be placed convenient to the driver. The earlier forms of automobiles were provided with forms of tillers very similar to those employed in controlling boats, but while these simple levers gave a certain degree of satisfaction on light cars operated at slow speeds, the development of the higher speed vehicles made necessary more easily handled and positive forms of steering gears. The disadvantages of the tiller are that it may be whipped out of the operator's hands by road irregularities, and it was very tiresome to hold because of the continual vibration.

With the modern forms of wheel-steering devices the hands are always in an easy position, the wheels may be readily operated, and because of the elimination of vibration by the feature of irreversibility provided by most steering gears of conventional construction, no road shock can loosen the grip of the driver, nor is he fatigued by continued movement of the wheel. Steering gears are made in a variety of forms and all types have their adherents. The accepted construction is clearly illustrated. In this the steering wheel is attached to a rod which carries a worm at its lower end. This worm meshes with a worm gear to which a steering arm is attached, and a rotary movement of the hand wheel will produce a reciprocating movement of the

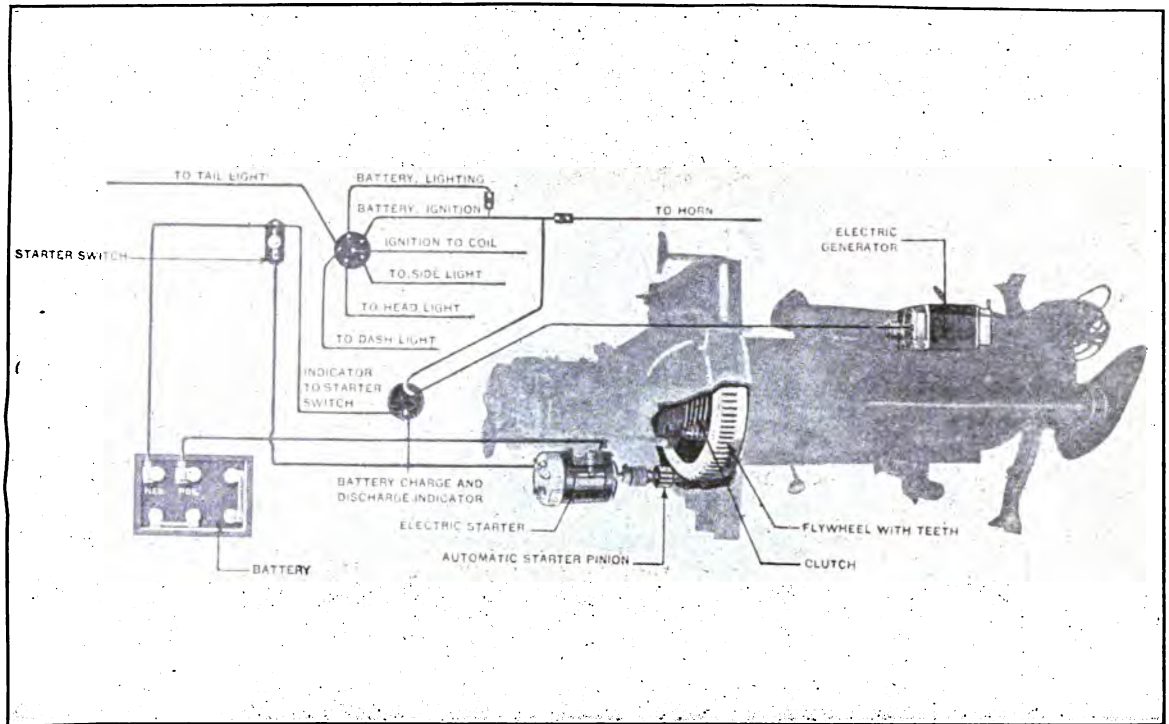


Fig. 21.—Parts of Chalmers 30 Starting and Lighting Systems.

steering arm at the lower end of the steering column. The steering arm is coupled to one of the steering knuckles of the front axle by a connecting link and the movement imparted to the one steering knuckle is transferred to the other one by means of the tiebar which joins them so they must move in unison.

Electric Starting and Lighting Systems.—One of the greatest improvements made in the modern automobile is the use of an

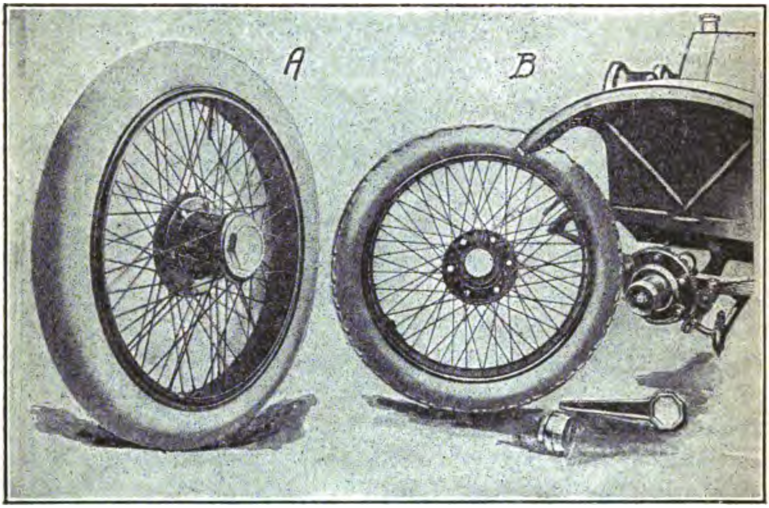


Fig. 22.—Typical Detachable Wire Wheel.

electric motor to start the gasoline engine, which relieves the driver of the hand cranking necessary on early models. As electric current is used for this purpose it is very easy to use it for lighting as well, which is another great convenience. Cars of several years ago used kerosene oil lamps and searchlights burning acetylene gas. The modern cars have more powerful lighting systems and at the same time the lights can be obtained by the simple act of turning of a switch. While electric lighting and starting systems are made in numerous forms, all of these may be arranged in two main classifications. The one-unit system is the simplest because in this a combined motor-dynamo

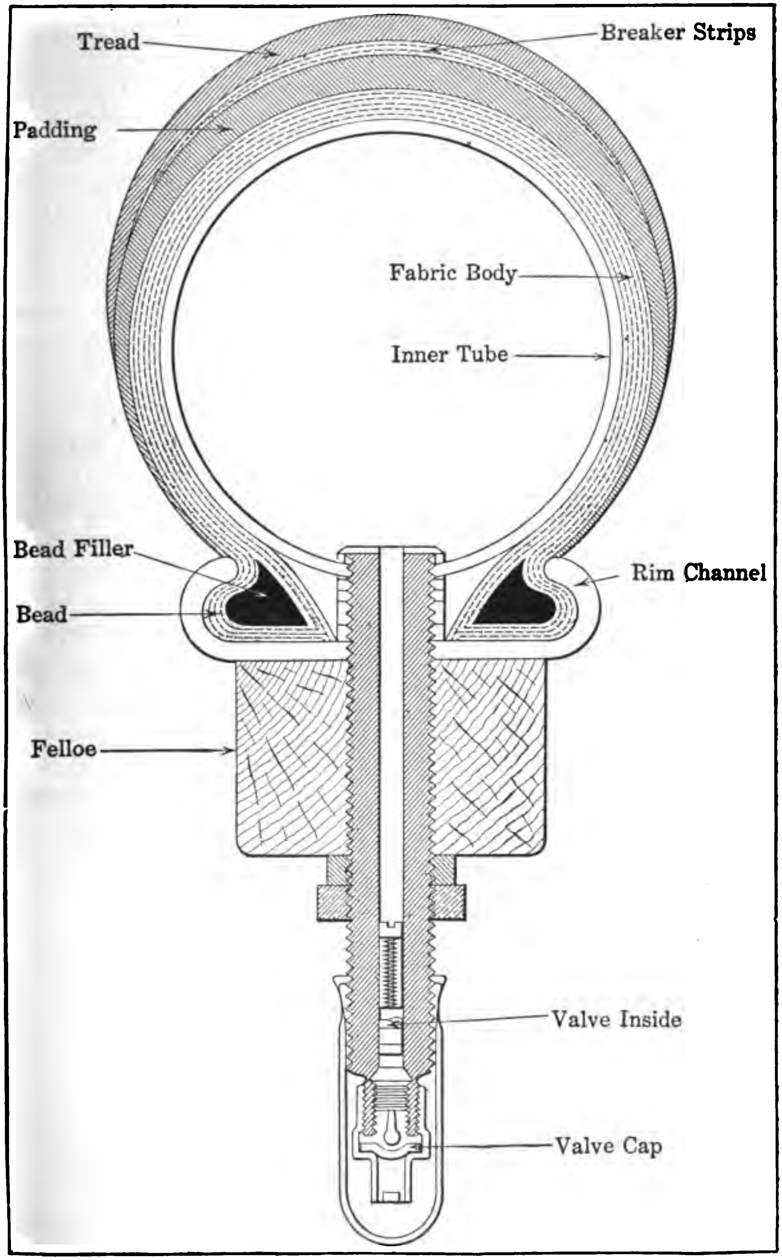


Fig. 23.—Outlining Construction of Pneumatic Tire Fitted to Simple Clincher Rim.

answers for generating current when the engine is running and for starting the engine when it is stopped. In the two-unit system, the main parts of which are shown at Fig. 21, the generator and starting motor are independent and uni-functional. The generator is used only to supply current to the storage battery. The starting motor is employed exclusively for turning over the engine crankshaft. This is easily accomplished by means of a small pinion carried by the armature shaft of the motor, which automatically engages a large gear cut in or attached to the flywheel rim.

It is not within the scope of work of this character to discuss electric starting or lighting systems at length. It is sufficient to explain that all the while the engine is running above a certain predetermined speed that the generator is delivering current to the storage battery. Some method of governing the current output is always provided to prevent the generation of too much electricity at high engine speeds and a consequent overcharging of the battery. Similarly a cut-out device is interposed between the storage battery and the generator to prevent the battery from discharging through the current producer when that was turning so slowly that it was generating the current weaker than that of the battery and therefore unable to oppose the flow of the stronger current. All that is necessary to bring the starting motor into action is to close the circuit between the storage battery and the motor windings by means of a foot-operated switch. If the ignition switch is closed so the spark takes place in the engine cylinders the engine will start after the flywheel has been turned over several times by the electric motor. The lights are supplied from the storage battery and are controlled by an independent switch.

Detachable Wire Wheel.—Many recent models of automobiles will be found equipped with wire wheels of some form or other. Improvements have been made in the method of lacing wire wheels so that the forms used for automobiles are very strong. This is due to a method known as triple spoke lacing as this provides a combination that permits the wheel to support radial, torsional, side thrust, and shock stresses in a much superior

manner to the old double spoke lacing formerly used on light automobiles and widely applied on bicycles and motorcycles.

A typical triple spoke wheel of Houk manufacture is shown at Fig. 22 A, while the method by which it is fastened to the master hub is clearly shown at Fig. 22 B. Most wire wheels are made so as to be easily detachable from a master hub which is not removed from the wheel spindle or axle and which is supported by the bearings or axle shafts. The wire wheel is built up with an auxiliary pressed steel hub as a basis which is provided with a series of holes to fit over driving pins attached to

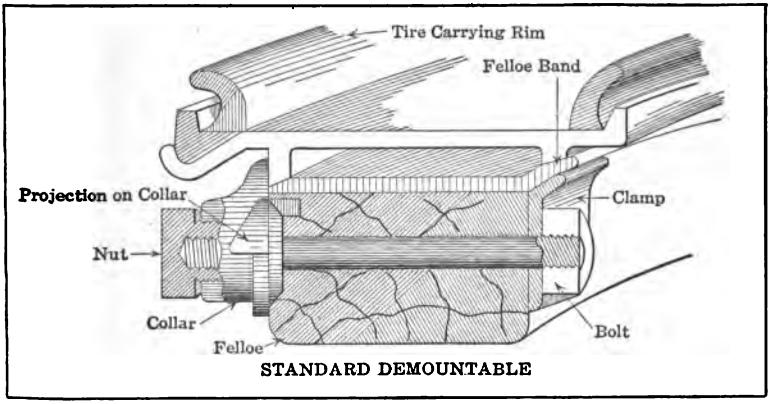


Fig. 24.—Quick Detachable Demountable Rim for Straight Side Tires.

the flange of the master hub and which is formed on the inside with two tapered seats, the angle of the tapers being opposed to each other. One of the male tapers forms part of the master hub which is shown at B in place on the front wheel spindle while the other male taper is on the locking nut. When the lock nut is screwed onto the threaded end of the master hub, which is sometimes termed the inner or fixed hub, it forces the female taper on the inside of the pressed steel wheel hub against the male taper on the master hub. The torsional force is applied to the wheel through substantial driving pins which engage with registering holes in the hub flanges. A spare wheel with fully

inflated tire may be carried and a quick change made in event of a puncture.

Pneumatic Tires and Rims.—The pneumatic tire of the present day is invariably of the double tube type and is composed of two members, the inner tube and the shoe or carcass. The inner member is utilized to retain the air and is made of a very pure rubber, about an eighth of an inch thick for cars of average weight. While this tube is very elastic and is air-tight, it would not be strong enough or have adequate resistance to be run directly in contact with the road surface; therefore it is necessary to protect it by a shoe composed of layers of fabric and rubber composition. The shoe member is provided with beads on its inner periphery designed to interlock with the rim channel, as shown at Fig. 28. The air is introduced into the tire through a simple form of automatic valve which is securely attached to the inner tube. As the inner tube becomes distended by the air pumped into it, it forces the beads of the tire outward and clinches the shoe so firmly in the rim channel that it will be impossible to dislodge it without the use of special tire irons, and then only when the air pressure is relieved from the inner tube.

In order to reduce the time occupied in changing tires, which is needed to adjust the shoe properly and blow up the inner tube, a number of demountable rims have been devised. The wheel felloe carries a metal rim, and to this is attached a second member on which the tire is mounted. The tire-carrying rim may be securely attached to the wheel by means of suitable and quickly operated clamping bolts, rings or wedges. When demountable rims are fitted, instead of carrying the usual deflated spare outer casing, fully inflated tires are carried on rims similar to the demountable portions, and when the tire is punctured the damaged one and its rim are removed as a unit and a new, fully inflated member replaced. When it is necessary to remove the shoe, as in the ordinary single-rim construction, the operation of replacing a tire will take from ten to fifteen minutes under favorable conditions, but with quick-demountable rims the operation of changing a tire will take

only two or three minutes. Demountable rims are more expensive than the simpler forms, but the convenience and elimination of time-consuming delay, as well as the saving in labor, more than compensates for the increased cost of equipment.

Numerous forms of demountable rims have been devised, but few have survived the test of time and have received general application. At Fig. 29 a combination of quick-detachable and demountable rims is shown. With this construction the advantages of both types are obtained without disadvantages of any moment, excepting those of cost of equipment. The quick-detachable type of rim makes it possible to change the tires very easily, should this be necessary, and makes for more easy removal for repairing when the damaged tires are restored to their efficient condition. In this form the tire-carrying rim is held on the felloe band by a clamping collar mounted on the stud and forced in place by a nut on the outer end of the stud. The construction is so clearly shown that its advantages will be readily understood.

CHAPTER II

GENERAL STARTING AND DRIVING INSTRUCTIONS

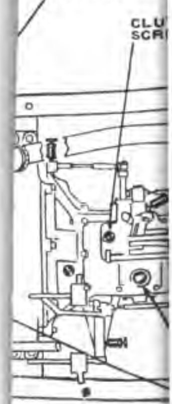
Suggestions for Oiling—How Motor Should Be Started—Handling Spark and Throttle Levers—Why Spark is Advanced—How Greatest Fuel Economy is Secured—Controlling Cars With Friction Transmission—Planetary Gearset Control—Operating Sliding Gearsets—Stopping the Car—Steering Wheel Position—Conventional Control System—Clutch Actuation Important—Shifting Gears Easily—General Driving Instructions—Rules of the Road and Motoring Courtesies—Things to Remember.

Suggestions for Oiling.—One of the most important points to be observed in connection with gasoline automobile operation is that all parts be oiled regularly. It is not enough to apply lubricant indiscriminately to the various chassis parts, but it must be done systematically and logically to secure the best results and insure the economical use of lubricant. The most important parts are the power plant and transmission system, and the engine is but one point in the car that must be properly oiled at all times to obtain satisfactory results. Some of the running gear parts are relatively unimportant, others demand regular inspection and oiling.

A very comprehensive oiling chart is presented at Fig. 25, this showing practically all of the points on a modern car that require oil as well as giving instructions regarding the character of the lubricant needed and how often it should be applied. Some of the points are governed by special instructions, these being the clutch, transmission case, timer and rear axle. The points of the clutch which need lubricant vary with the form of the clutch employed. Multiple-disk types which run in oil must be kept filled up with the proper grade of lubricant. At the other hand, cone and dry plate clutches work better without

ubricat

ve the desired



oil from the mo
side of motor, a
approximately 2
easpoonfuls of k

art of the Hu
Grease Cups at
oiles Require t

ay l
nploy
ith a
get
an be
al h
an o
ffici
ock
e b
Ne
e r
old,
r n
ecau
nd f
xle
etro
onsi
igh
ase
lace
he
T
s l
hen
ew
nd
f tl
ars
or
will
the
roll

join
plu

any lubricant between the surfaces. When a cone clutch is employed, it is sometimes desirable to soften the leather facings with a little castor oil or neatsfoot oil, if the action is beginning to get hard. A transmission gear case which is moderately tight can be filled with a good grade of steam engine cylinder oil, and real heavy grease should not be used if the transmission shafts run on ball or roller bearings. A heavy cylinder oil will have sufficient viscosity to cushion the teeth of the gears against shock and at the same time it will not be too heavy to flow into the bearings and lubricate them properly.

Neither the transmission case nor the differential case on the rear axle should be filled with the heavy "dope" widely sold, which may contain wood fiber or cork particles to make for more silent gear operation. If gearing is noisy it is either because it is worn or out of adjustment, and the use of nostrums and freak lubricants will not improve their operation. The rear axle differential housing should be filled with a medium, pure petroleum grease as it is possible to get, those having about the consistency of vaseline being the most desirable as lubricants. Light oils should never be used in either the transmission gear case or in the rear axle housing, because these will not stay in place, will leak out and will not have sufficient body to cushion the gear teeth.

The only other point on the chart which needs explanation is lubrication of the timer interior. This should only be oiled when it is a roller contact form, as on Ford cars, and then a few drops of dynamo, magneto or spindle oil applied to the roll and the contact segments once a week is all that is necessary. If the timer is a form using platinum contact points, as on most cars, it does not need any lubricant. Never use graphite grease or any heavy oil in a timer or distributor case because these will not only interfere with regular ignition by short circuiting the current, but they will clog up the timer and prevent the roller establishing proper contact with the segments.

After a car is oiled it is well to go over all the exposed joints with a piece of cloth to remove the accumulation of surplus oil or grease on the outside of the parts, which serves no

useful purpose and which only acts to attract and retain dust and grit. The instructions given on the chart can be followed to advantage on practically all types of gasoline cars, though, of course, the different constructions will have to be treated as the peculiarities of design dictate.

How the Motor Should Be Started.—One of the most important points in the education of the novice motorist is the best method of starting the motor if a self starting device is not provided. Before the engine is set in motion certain precautions must be observed regardless of the make or type of car. The gasoline tank, radiator and lubricating oil container should be inspected to make sure there is enough fuel, water and lubricating oil. The shut-off valve in the pipe line leading from the gasoline tank to the carburetor is opened so the fuel will flow to the vaporizer. The carburetor should be primed by means of a small plunger usually carried in the floatbowl cover, and if a small resistance is felt to the downward movement of the primer or if gasoline escapes from the bottom of the mixing device, this may be considered a positive indication the fuel from the tank has reached the carburetor and that gasoline is present at the spray orifice. The next step is to see that the change-speed lever is in a neutral position or that the clutch pedal is disengaged. The spark control lever, which is usually carried on the steering wheel, should be set at full retard point. In some cars this may be at the back of the sector, while the retard position may be the other extreme in other motor cars.

If one attempts to set an engine in motion by means of a hand crank with the spark lever advanced so that an early spark is obtained, the motor may "kick back," and this reversal of motion, which is due to premature combustion, may sprain the wrist or break an arm. It will be well to open the throttle or gas lever a little to insure that a charge of combustible gas will be inspired into the motor. The engine should be turned over several times as briskly as possible, and then the switch which completes the electrical circuit between the battery and the ignition mechanism should be put into circuit and the switch plug inserted. The hand crank is pushed in until it engages

a ratchet member on the front end of the crankshaft, and then the motor should be turned by pulling up on the starting handle with the left hand.

The hand crank should always be engaged so that an upward pull will be necessary to turn the crankshaft, and the point that cannot be too firmly impressed upon the embryo motorist's mind is that gasoline engines should always be started by pulling up on the handle of the starting crank, never by pushing down. If the starting handle has been properly placed and the engine has been turned over enough with the switch open so the cylinders hold a gas charge, and the switch circuit is closed when a decided resistance is felt as the crank is turned, indicating that the piston in the cylinder in which the gas charge is about to explode is nearing the compression point, a single quick, strong up pull on the crank should be sufficient to start any properly adjusted motor.

Multiple-cylinder engines, especially those of the four and six-cylinder types, are started much more easily than the one and two-cylinder forms. These can often be started by turning the starting handle over briskly so the motor will take in gas but without the switch closing the electric circuit. To start the motor the switch is closed and a spark will be produced in the cylinder about to fire (only in cars equipped with battery ignition) by moving the spark lever from one end of the sector to the other. As soon as the engine becomes started it should be kept from racing by shutting down the supply of gas to the point where the motor will turn freely and yet slowly.

Handling Spark and Throttle Levers.—Most hydrocarbon vehicle motors have a certain degree of flexibility, i. e., they may be run slow or fast, and the speed may be accelerated or cut down as desired within a range from 200 revolutions per minute to the maximum, which will vary with the type of motor, some running as high as 3,000 r. p. m. This is an important advantage, inasmuch as it permits one to regulate the vehicle speed on most occasions by a touch of the throttle alone. The engine speed of practically all automobiles is controlled by two ways, though usually these are employed in conjunction. One of these

consists of varying the time of the spark in the cylinder, the other regulating the amount of gas supplied. The throttle, in some cases, may be controlled by three distinct means. One of these is a governor which shuts off the gas supply automatically if motor speeds exceed a certain predetermined point. Governors are used only on commercial vehicles. The governor may be temporarily dispensed with by pressing down on the accelerator pedal, which will open the throttle directly, or by means of the throttle lever carried on top of the steering column. The usual method of driving is to set the throttle lever at a point which will give the minimum speed desired and depend upon the accelerator to take care of other speed fluctuations. The function of the spark lever is to regulate the time of sparking to the point best suited to the needs of the engine.

The question of motor speed regulation seems to be a simple one, but many motorists learn proper methods of spark and throttle lever placing only after considerable driving experience has been obtained. Motor speed regulation depends upon two factors. First, advancing the time of sparking to the most efficient point after the engine has once been started; and, secondly, increasing the amount of mixture supplied the cylinders. The spark and throttle levers, while designed to be manipulated independent of each other, usually move with a certain definite relation. It would not be good practice to run an engine with the spark lever way advanced and gas supply throttle nearly closed; nor would good results be obtained if the spark lever was retarded and the throttle opened as it is desired to increase the motor speed. It is not difficult to understand the function of the throttle lever and how the admission of more gas to the cylinders would act in creating more power, just as augmenting the steam supply to a steam engine will increase its capacity.

Why Spark Is Advanced.—The rules for manipulation of the spark lever are not so well understood. In order to make clear the reason for intelligent manipulation of the spark handle there are certain points that must be considered. On most automobiles there is a position of the spark lever, usually at the center or intermediate point of the sector over which it moves,

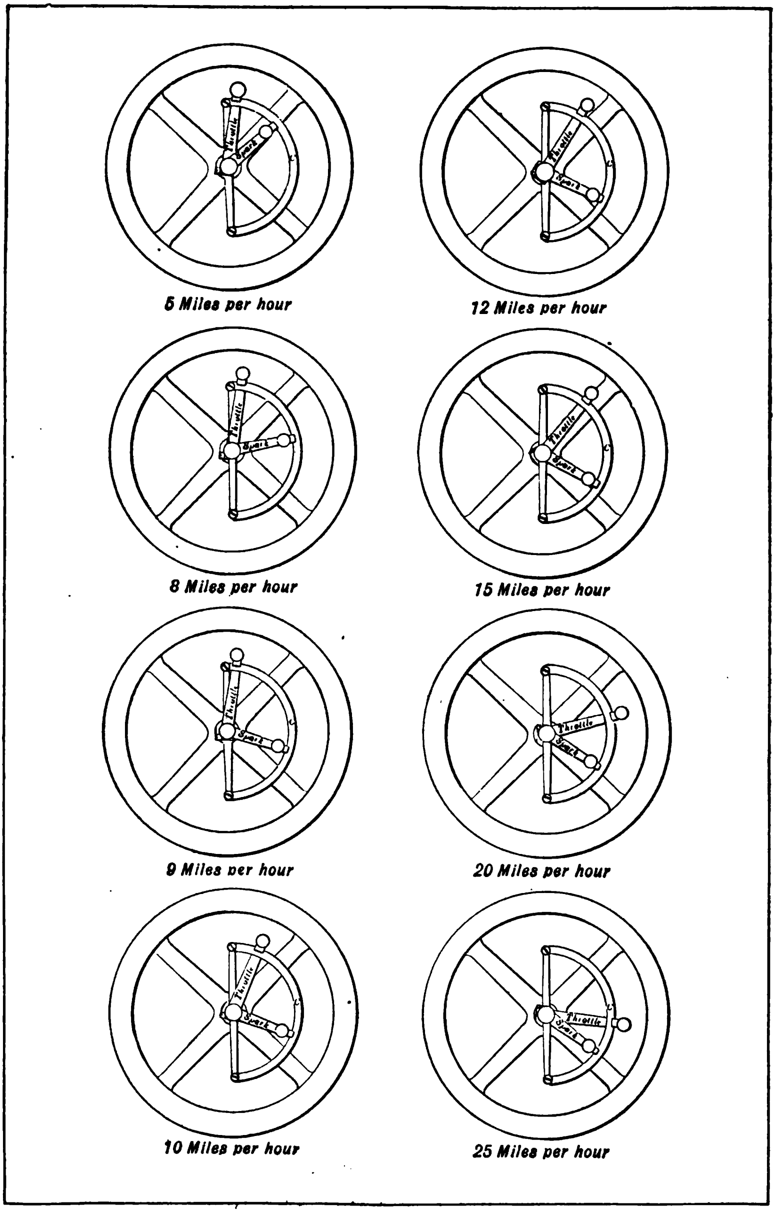


Fig. 26.—Showing Various Positions of Spark and Throttle Levers for Obtaining Different Car Speeds.

which corresponds to the normal firing point. If the spark lever is not advanced beyond this position, and the motor is turning over slowly, the gas in the cylinders is being exploded when the pistons reach the end of their compression stroke. When the gas is fully compacted the explosion or power obtained from combustion is more powerful than if the spark fired gas which was not compressed properly. The electric spark is not produced at the exact time that the motor should be fired at all speeds, and if the spark was supplied the very instant of full compression, irrespective of the speed of rotation, there would be no need of moving the spark lever.

Not only is the current apt to lag, but it takes a certain definite amount of time to set fire to the gas. It requires nearly the same amount of time to ignite the gas, of given composition, regardless of the speed of the motor. If the motor is only turning at a few hundred revolutions per minute there is ample time to ignite all gas charges positively, but if the motor speed increases, and the explosions occur oftener, then one must compensate for the more rapidly occurring combustion periods by arranging to start igniting the gas earlier so the explosion will actually occur when the piston is at its highest point in the cylinder. The compensation for lag is made by advancing the spark. The spark lever on the steering wheel or column moves a timer distributor, if battery system is employed, or the magneto contact breaker box, if that form of current producer furnishes the ignition energy. The amount of spark advance needed depends on engine speed, and the greater the piston velocity the more the spark should be advanced.

It is possible to advance the spark lever too far, and when this occurs the gas is exploded before the piston reaches the top of its stroke and premature explosion takes place. As a result of this the upwardly moving piston is forced to overcome the resistance exerted by the expanding gas of the ignited charge in completing the remainder of the compression stroke, and before it will return on the power stroke. The injurious back pressure on the piston reduces the capacity of the motor and a pounding noise similar to that produced by loose motor parts

gives positive indication of premature ignition due to excessive spark advance.

At the other hand, if the spark lever is not as far forward as it should be, the explosion may be late because of the "retarded spark." If the spark occurs late in the cycle, the charge is not fired until the piston has reached its highest point and after it has completed a small portion of its next downward movement. As the point of maximum compression is passed and the piston moves down in the cylinder, the size of the combustion chamber augments and the gas begins to expand again before it ignites. Owing to the moderate compression the power resulting from explosions is less than would be the case with a higher degree of compression. To secure power it is necessary to supply more gas to the cylinders. Driving with a retarded spark produces heating of the motor and is wasteful of fuel.

For ordinary running the spark lever is usually placed about midway of its travel on the sector, and as a general rule an engine with magneto ignition does not require the frequent manipulation of the spark necessary when current is produced by a battery. As the engine speed increases the current produced by the magneto is proportionately augmented, and the spark lever need not be advanced from the center position except under conditions which permit of exceedingly high speeds.

The diagram presented at Fig. 26 was furnished by the Cadillac Motor Car Company to owners of its four-cylinder cars, and shows the position of the spark and throttle levers to obtain various engine speeds when the car is on the direct drive. At five miles per hour the throttle is practically closed and the spark lever has been advanced about a quarter of the way down the segment. To obtain a speed of eight miles per hour the spark lever is moved to the point on the steering wheel sector indicated by the letter C. The throttle lever is not disturbed. Moving the spark lever about two-thirds of the way on the sector will increase the speed of the car to nine miles per hour. From this point speed ratios are augmented by moving the throttle lever and the car speed increases progressively as the amount of gas supplied the engine is augmented. For higher

speeds than twenty-five miles per hour the spark and throttle levers are moved toward the end of the sector and it is good practice to advance both in conjunction beyond this point.

How Greatest Fuel Economy Is Secured.—Summing up, it will be evident that the greatest economy of fuel consumption will result when the car is driven with as little throttle opening as possible and with the greatest spark advance the motor speed will allow. To obtain maximum power, as in hill climbing on the direct drive, the spark lever should never be advanced beyond center and the throttle should be opened as wide as possible. For extreme high speeds the throttle should be advanced to a point about midway of its travel before the spark is advanced beyond that point. If this does not give the required increase in speed, the spark lever should be advanced as far as possible and the amount of gas increased, by moving the throttle lever from its central position to the extreme position on the sector. Control lever placing varies on nearly all cars, but the most common position is on top of the steering column, where they are convenient to operate and very accessible. In some cars the spark and throttle levers may be placed under the steering wheel and on one side of the steering post, one being located above the other. In other vehicles, they are disposed under the wheel and on opposite sides of the steering post. Some designers do not furnish variable spark when a magneto is used for ignition. The magneto contact breaker is advanced to the point where the best operation under average conditions is attained, and motor speed regulation is entirely by using the throttle lever or accelerator. Many battery ignition systems have automatic spark advance mechanism in the timer-distributor.

Controlling Cars with Friction Transmission.—After the engine has been started the next point is to put the automobile in motion. The means for obtaining the various speed ratios will determine the steps that should follow. When a friction or old style planetary transmission is installed the control is very simple and a single hand lever suffices to furnish all desired speed ratios. One hand lever at the side of the car serves to move the drive member to its various positions on the face of

the driving member. One foot pedal is employed to bring the friction disks together and establish driving contact between them when the proper speed position has been selected with the hand lever. The other pedal is used to apply a running brake at the rear wheels. Motor speed is regulated by spark and throttle levers on the steering wheel. Friction drive cars are rare at the present time, only one make, the Metz, being used extensively.

With this form of control the friction pedal is released before the engine is started, and as this breaks the driving connection between the friction disks the engine can turn without moving the vehicle. After the motor is started in the manner previously indicated, the speed changing lever is placed at a position about midway in its travel. This gives one of the lowest speed ratios. To start the car the friction pedal is pressed with the left foot until sufficient pressure exists to cause the driving member to turn the driven wheels and transmit the engine power to the rear wheels. After a certain degree of headway has been attained, the friction pedal is allowed to return to its free position and the hand lever is pushed forward a few inches to give a slightly higher speed. The friction pedal is again depressed and when sufficient pressure is exerted the car will move forward at a higher speed. The farther forward the handle is placed the higher the vehicle speeds, and if the handle is brought back beyond a central position a reverse motion is obtained.

The friction pedal may be locked at any desired point by tilting the foot pad up by raising the heel. When it is desired to stop the car the friction pedal is released by bearing down on the lower portion of the foot pad, which loosens the ratchet lock, and then pushing on the brake pedal. It is important that the friction pedal be applied gradually and that it is not pressed down any farther than is necessary to drive the car. The amount of pressure will depend on the road conditions, and the lighter the degree of pressure the less wear will take place on the friction wheel fiber ring. When on a hill, or in sand, the friction pedal will have to be pushed up harder than when the car is driven on a level highway with a good surface.

Before the hand lever is changed from one position to another the friction pedals should always be released. An emergency braking effect may be obtained by pushing the hand lever in reverse position and applying the friction pedal if the car is going forward, or *vice versa,* if the car is traveling in a reverse direction. One of the advantages of the friction transmission is that it is difficult to injure it by careless handling because there are not gears to be stripped, as none are used. The transmission is practically noiseless and speed changes are effected easily.

Planetary Gearset Control.—One of the advantages of the planetary gearset, when applied in the two speed forward and reverse forms as in early Maxwell cars, is that the method of obtaining the various speed ratios is very simple and easily understood. The speed changes are obtained by a single hand lever and the hub brakes are applied by the usual form of pedal. Five positions of the handle give two neutral points, one reverse motion and two forward speeds. Ordinarily the lever is in an approximately vertical position and is at the neutral point between the reverse and slow speed. When pulled back from this position a reverse motion is obtained. If pushed forward the slow speed gears are put into action. Moving the hand lever from the slow speed position forward gives the second neutral point, while the high speed or direct drive is obtained by pushing the lever to the extreme forward position. The lever must be held in reverse position but can be locked into low and high speeds.

When running the car under conditions where it is not necessary to go into the reverse the lever may be pulled from the high speed position to the neutral point between high and slow speeds. If the car is stopped it can be easily started forward again by pulling the handle back into slow speed from neutral position and then forward to engage the direct drive. If the handle is pulled way back out of high speed into neutral position between slow and reverse, either of these ratios may be easily obtained. A point necessary to consider when operating a planetary transmission is that the slow and reverse speed must be

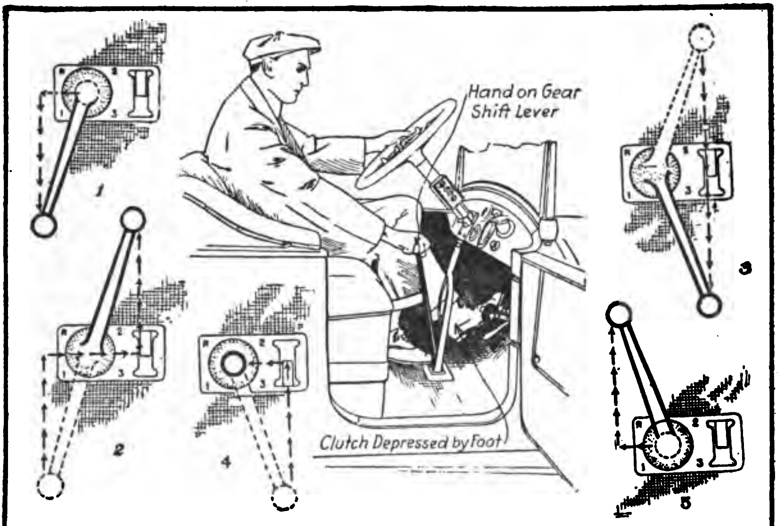
applied gradually and that the engine be speeded up pretty well before either reverse or slow speed bands are tightened. After the car has attained a certain degree of momentum on the low speed the lever should be put forward into the high speed position gradually in order to avoid the sudden jump which always obtains when changing from the low to the high speed of a two-speed car. This jump is caused by a sudden acceleration due to the higher gearing, provided by the direct drive position which is much higher than the maximum speed permitted by the slow speed gears.

Operating Sliding Gearsets.—Two sliding gear systems are fitted to motor cars, but at the present time the progressive system of control has been almost entirely superseded by the selective system. The principles of operation are practically the same as relate to clutch operation and gear engagement, but in the progressive system it is necessary to move the gear-shift lever from one end of a segment to the other to obtain the range of speed. In the selective system a gate segment or cane shift is utilized and the hand lever is moved only short distances to select the speed required. The progressive system is practically obsolete.

In operating a car with the selective method of control it is necessary that the gear-shift lever be in a neutral point if the clutch is engaged before starting the engine. After the motor has been started and is running at the proper speed, and it is desired to start the car, the first step is to release the emergency brake lever and depress the clutch pedal so that the driving connection between the engine and gearset is interrupted. With the clutch pedal depressed fully the hand lever is pushed into the slot which will give the slowest speed; then the clutch is allowed to engage slowly and the start forward is made on the lowest speed. After a certain degree of momentum has been attained the clutch pedal is again depressed and the speed lever shifted into the next higher speed ratio. The velocity of the car is thus gradually increased by moving the lever in steps from the lowest to the highest ratio. With any form of sliding gear transmission it is imperative that the clutch be released every

time a change of speed is to be made and the clutch should not be engaged again until the gearing is positively in mesh.

Stopping the Car.—When one desires to stop the car, the first step is to release the clutch by pushing forward on the clutch pedal with the left foot and apply the foot brakes with the right foot. The gear-shift lever is brought into a neutral point and then the clutch may be engaged again if desired. On some cars the emergency brake lever and clutch-shifting mechanism are interlocked in such a manner that the clutch is released automatically when the hand brake lever is applied. The emergency brakes of the average car are seldom used in normal operation, the main reliance of most drivers being the foot-operated service brakes. When it is desired to lock the car the emergency brake lever is pulled back until the brakes are engaged and is retained in that position by a locking ratchet that engages suitable teeth cut into the brake lever segment.



1 Neutral to Low Speed 2 Low to Second Speed
3 Second to High Speed 4 High Speed to Neutral
5 Neutral to Reverse

Fig. 27.—Gear Shifting Method on Overland Model 75 Cars.

Steering Wheel Position.—There is now but little difference of opinion regarding the placing of the steering wheel and whether it should be on the right or left side of the car. Most American motor cars, which originally were copies of foreign productions, formerly placed the wheel and control levers at the right side of the car, because they were disposed in this manner on the European cars. The road rules in Europe are different than in this country in that a driver has to pass a vehicle going in the same direction on the right and must keep to the left of the road. This made the right hand placing of the wheel logical and desirable. In this country, however, the rules of the road are that all vehicles must keep to the right and when one passes another conveyance going in the same direction it should be passed on its left side. This makes the right-hand control, which is logical and desirable in Europe, unsuitable for road laws of this country.

Fig. 28.—How to Make an Emergency Stop With Overland Model 75 Control System.

Conventional Control System.—To be logical the steering wheel of American cars is placed at the left side instead of the right. Most designers now follow this rule, but in order to conform as much as possible with former American practice the gear shift lever is placed in the center of the car where it can be operated by the right hand instead of at the left side. Sometimes a single hand lever is mounted in the center of the floor board and is moved in four directions. It may be rocked to the

right or left and pulled back or pushed forward in either of these positions. When the lever is straight up and down it is at the neutral point, the three forward speeds and reverse motion are obtained by rocking the lever from side to side and pushing it forward or backward as conditions demand, as shown at Fig. 27. Two pedals are provided. That at the extreme left serves to release the clutch and apply the service brake, while the one

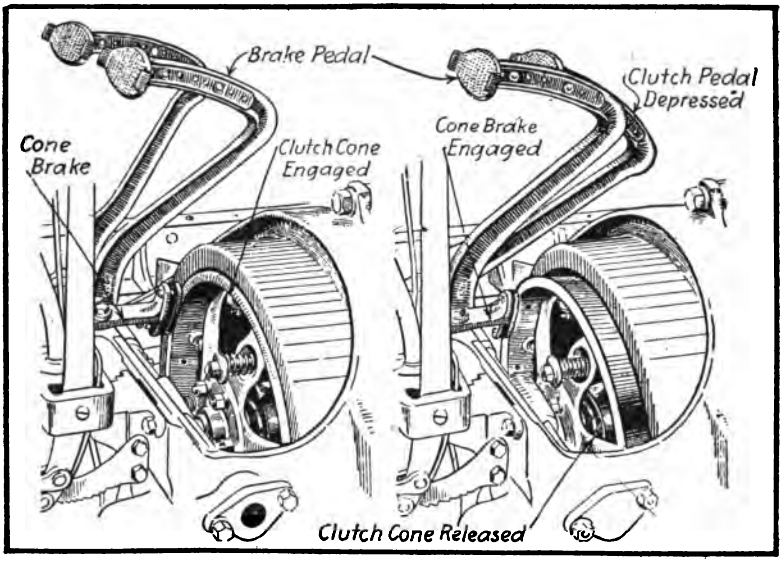


Fig. 29.—Illustration Showing Action of Cone Clutch on Overland Model 75 Cars.

operated by the right foot actuates the emergency brakes. When a single pedal is used for service brake application and clutch release, it is depressed about half its travel to disengage the clutch and applies the running brake from that point to the end of its radius of movement.

The instructions given for operating one type of car with selective sliding gear transmission apply just as well to all other forms, which are controlled in practically the same manner and which differ only in the arrangement of the slots in the guiding gate and the location and direction of movement of the

spark and throttle levers. Practically the same units are used in all control systems of sliding gear cars, i. e., two pedals and two hand levers are usually provided. One of the pedals invariably releases the clutch while the other applies the service brake. One hand lever, nearly always the one nearest the operator, is used to shift the gears, while the one that works on a notched

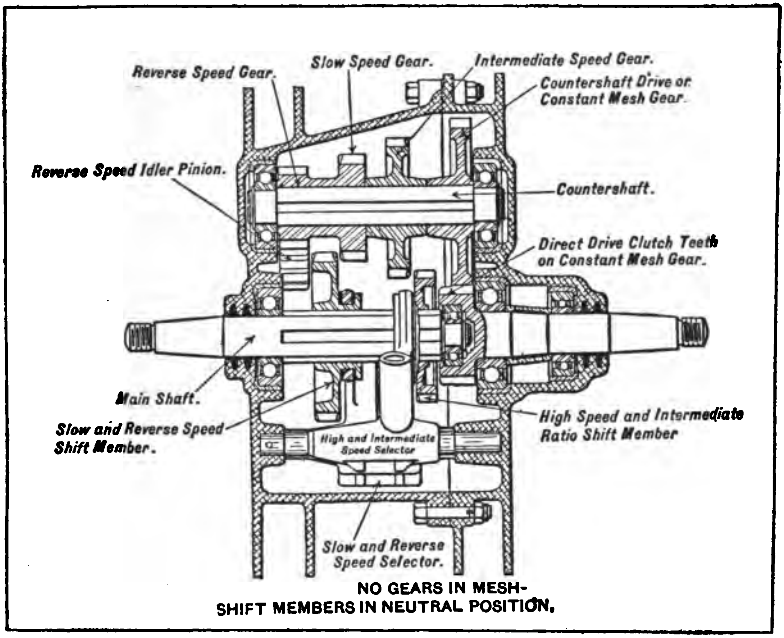


Fig. 30.—Sectional View of Three Speed Selective Gearset, Showing Position of Sliding Gear Members When Control Lever is in Neutral Position.

segment is depended upon to apply the emergency brakes. The differences in the control groups of leading American automobiles are described in detail in next chapter.

Clutch Actuation Important.—The following instructions apply to all types of gasoline automobiles and may be followed to advantage by all motorists. The gear shift lever should always be placed in a neutral position when the car is stopped,

whether it is left alone or attended. Gear shift levers should always move easily and the clutch pedal of all cars equipped with sliding gear transmission should be fully depressed before attempt is made to shift speeds. The clutch should always be applied gradually and as slowly as possible because too sudden or harsh engagement will produce stresses that will injure the

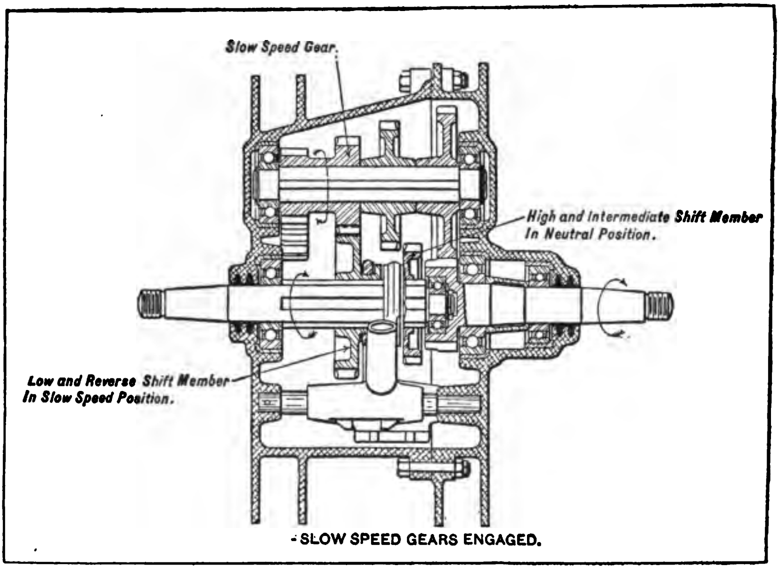


Fig. 31.—How the Large Sliding Gear Member is Shifted by the Control Lever to Obtain Slow Speed.

tires or mechanism of the chassis. Never allow the engine to race or run excessively fast when shifting gears, and it is well not to undertake to change speeds with either motor or car running at high speed. When changing down, i. e., from a higher to a lower gear, allow the car to slow down until its speed is about the same as that which will be produced by the lower gear ratio desired before the clutch is again engaged after the gear lever has been shifted.

Shifting Gears Easily.—If difficulty is experienced in meshing the gears, do not try and force them in mesh but hold the

clutch pedal out for a few minutes, let the car come almost to a stop, apply the clutch quickly and release it at once, and the chances are that the troublesome shift member will have turned to a position where it will engage more easily. Sometimes one or more of the gear teeth on the shift member or the gear with which it engages may be burred up on the edges and will not

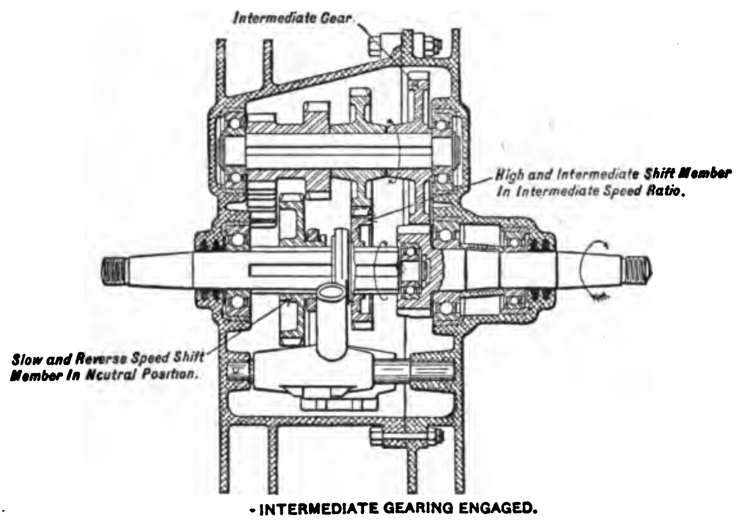


Fig. 32.—How the Small Sliding Gear is Shifted to Obtain the Intermediate or Second Speed Ratio.

engage promptly, whereas other portions of the same members will have undamaged teeth that will easily slip into engagement.

General Driving Instructions.—Always drive a car slowly and cautiously until you are thoroughly familiar with the control mechanism and the methods of stopping the car. When driving up grades on the higher ratios, if the motor shows any tendency to labor, shift back into a lower gear ratio which has been provided for that purpose. Many motorists believe that the best test of a car's ability is to rush all hills, or bad spots in roads, on the direct drive. It should be remembered that the lower

speed ratios were provided for use at all times when employing the third or fourth speeds might produce strains in the motor. All unusual noises should be investigated at once, as these sounds usually presage more or less serious trouble. A gasoline car should never be driven with a slipping clutch, and it is imperative that the brakes and steering gear be frequently inspected to make sure that they are in proper order.

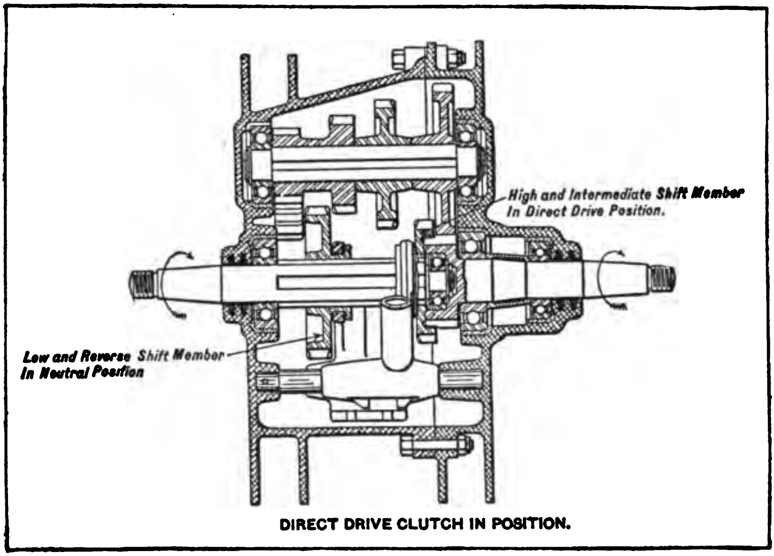


Fig. 33.—How Small Sliding Gear is Shifted to Lock the Two Portions of the Divided Main Shaft Together and Secure the Third Speed or Direct Drive.

One should never attempt to drive cars at high speeds unless the tire casings are in perfect condition and the road surfaces good. In driving on clay or muddy roads, or on wet asphalt, care must be taken in turning corners and the car should be driven cautiously to avoid dangerous side slipping or skidding. When driving on unfavorable highway surfaces always keep one side of the car on firm ground, if possible. Brakes should always be carefully applied, especially if the road surfaces are wet. An automobile should never be brought to a stop in mud, clay or sand, snow or slush, if it can be avoided. Whenever road condi-

tions are unfavorable, the smooth tread tires of the driving wheels should always be fitted with chain tire grips to insure having adequate traction.

All motorists should familiarize themselves as much as possible with the mechanism of their cars and should be competent to make the ordinary adjustments and minor repairs before any

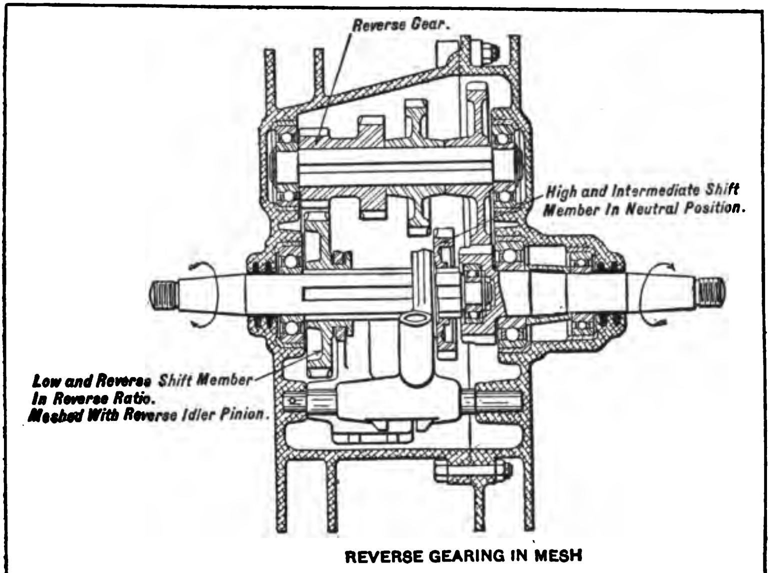


Fig. 34.—How the Large Sliding Gear is Shifted to Secure the Reverse Drive.

long trips are attempted. A full equipment of tools and spare tires and casings should be carried at all times. It is well to remember that the manufacturer of the car has issued a set of instructions for its care and maintenance, and these should be followed as closely as possible because intelligent care of any piece of machinery means long life and reliable service and the automobile is no exception of the rule. Various rules of the road, motoring courtesies and useful information taken from the King 8 instruction book are summarized in following paragraphs that can be read to advantage by all motorists, regardless of the cars they drive.

RULES OF THE ROAD AND MOTORING COURTESIES

One of the first things that the new driver learns is the advantage to be derived from consideration and courtesy extended to others using public highway. Most drivers know that they are expected to turn to the right when approaching a vehicle, or to the left in overtaking and passing a slow moving vehicle going in the same direction. After they have come to realize the accuracy with which their car may be steered and the ease with which it may be called upon to pass and leave behind another vehicle, possibly approaching from the opposite direction, it seems natural for some drivers to display their nerve in not turning from the center of the road until they are almost upon the approaching vehicle. Often, however, the other fellow has as much courage and takes the same stand, and in the confusion which very frequently follows, either one or both cars are damaged on account of collision. In passing vehicles which are approaching, as large a margin of space as possible should be afforded, and in passing a slow-moving vehicle ahead, pass him as quickly as possible and without cutting in short ahead of him.

City Traffic Regulation.—The lack of consideration on the part of a few careless drivers has resulted in the adoption of very strict municipal regulations governing traffic. Those who are familiar with city traffic regulations and apply them as well on country roads, will not be likely to encounter difficulties. The burning of at least three lamps, including two head or side and one tail lamp, is enforced from sundown to sunup in practically every State. Dimmer bulbs are usually provided in the head lamps so that side lamps are not necessary.

Road Crossings.—In approaching an intersection, either in the city or in the country, where a clear vision of the road approached cannot be had on account of buildings, fences, etc., obstructing the view, the car should be slowed down to a speed at which it can be readily stopped in case of the approach of another vehicle at either side.

Turning into Another Road.—In turning a vehicle into another road to the right, the driver should keep his car as near the right-hand curb as practicable. In turning into another

road to the left, he should turn around the center of the two. No vehicle should be slowed up or stopped without the driver thereof giving those behind him warning of his intentions to do so by proper signals. See diagrams in Fig. 35.

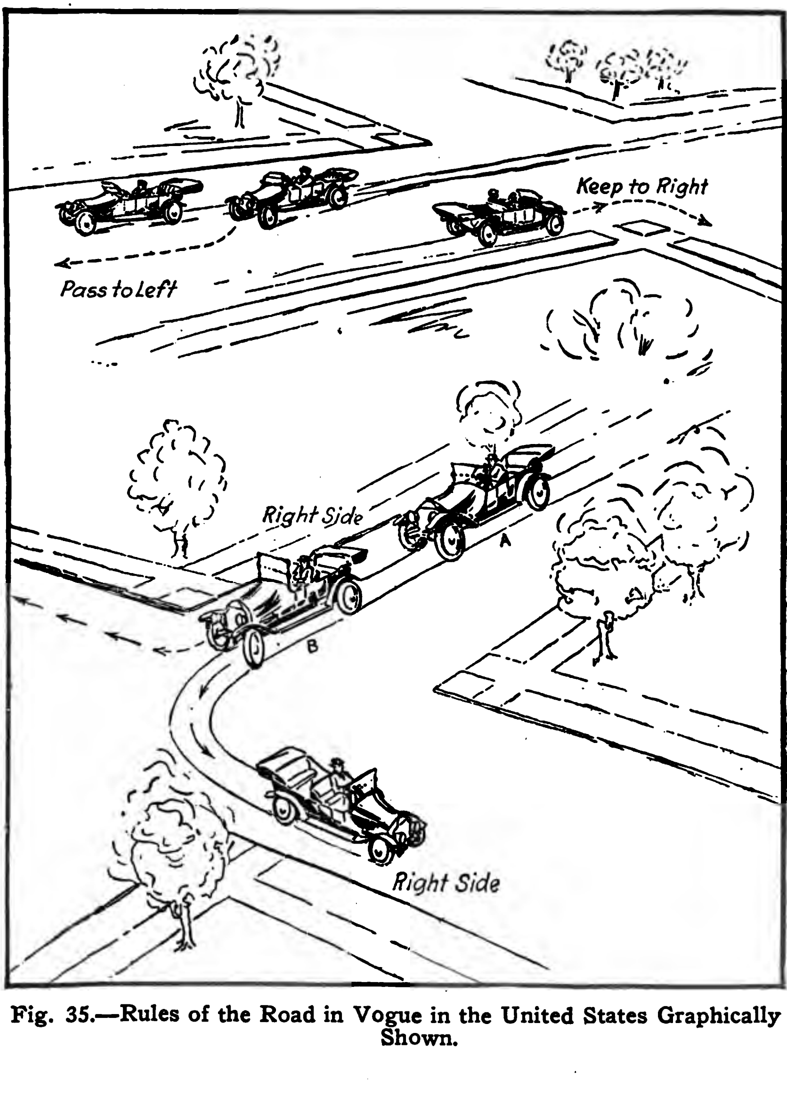


Fig. 35.—Rules of the Road in Vogue in the United States Graphically Shown.

Approaching Railroads.—In approaching a railroad crossing, especially if there is an incline or grade, the gear shift lever should be dropped back into second speed and the approach made carefully, first to determine whether to make the crossing or not, and, second, to be in a position to accelerate your car suddenly with very little chance of stalling the motor. Many accidents have happened because inexperienced drivers have become confused and stalled their motors. On noting the approach of the train, they have thrown on their power, or let in their clutch suddenly, with the result that the motor is stalled on the track and it is then too late to move out of danger. Better Stop, Look and Listen as the warning sign advises.

Changing Gears.—More accidents result from unwillingness to change gears than from almost any other cause. Most American drivers use their first and second speeds only in starting their car. They allow the car to drift along and thus get into a tight place in traffic or too close to street cars, and because of misjudging the speed of the approaching vehicle, or their selfish desire to crowd out another car, collisions or other accidents frequently result. It is a simple operation to change from third to second speed. It increases your power and affords the possibility of a great deal quicker acceleration as well. The second speed is incorporated for a purpose. It is seldom that we are in such a hurry that we cannot spare a moment to afford absolute safety.

Accidents Not Due to Losing Control of Car.—Accidents are not due to the driver losing control of the car in many instances, but are more likely due to his losing control of himself. One is not an expert driver until he intuitively performs the operations which control the car just as naturally as he walks or reaches out for an object.

When the Car Skids.—Although the driver feels helpless at first, a little experience will soon give him confidence. Most skids can be corrected by the manipulation of the steering and brakes. An expert driver can keep his car straight under almost any conditions, but it is impossible to explain just how he does it. Usually the rear end skids first, and in the right-hand direc-

tion, this being caused by the crown of the road. Under such conditions, the skidding action will be aggravated if the brakes are applied, and the car may be ditched or continue to skid until it hits the curb. The correct action in an emergency of this kind is to close the throttle to shut off the power; but not entirely so, or it will have the same effect as putting on the brakes. If the car seems to right itself, the power may be applied gradually, and it will be advisable to steer for the center of the road again. However, if the car continues to skid sideways, steer for the center of the road, applying the power gently. This will aggravate the skid for the moment, but will leave you with the front wheels in the center of the road and the car pointing at an angle. By so doing you can mount to the crown of the road again and the momentum of the car will take the rear wheels out of the ditch on the right-hand side. It is customary to advise turning the front wheels in the direction that the car is skidding in order to correct the action, but this can hardly be said to be true in all cases, as the amount of room on the skidding side is somewhat limited, and for this reason the explanation given above will better apply to such a condition.

When turning a corner on asphalt pavements which are slippery, it frequently occurs that the front wheels skid. In a case of this kind, immediate action is necessary. It will usually be found that by applying the brakes suddenly for a moment so as to lock the wheels, the rear end of the car will skid in the direction in which the car is to be turned. This will help the action of the front wheels, and the releasing of the brakes and the touch of the accelerator will bring the car around the corner without any over-travel of the front end. By applying the brakes in this way, it is possible to turn the front wheels in the direction opposite to that which the car is to be turned for a moment while the rear end is skidding. When the brakes are released, it is plain to see that the front wheels will have no tendency to skid farther, as they will be pointing in the direction in which the car is to be turned and the rear end will be in line with it, due to the skid. Needless to say, this manipulation requires a

little more expertness than the correction of an ordinary skid on a straight road.

In Crossing Street Car Tracks and Climbing Out of Ruts.—Skidding can be prevented and accidents avoided, also the life of your tires lengthened, if you will learn how to turn your car out of street car tracks and ruts. Make a sharp turn of your front wheel. Do not allow the wheel to climb along the edge of the rut and finally jump off suddenly, and do not attempt to climb out of those conditions at high speed.

Turning Corners at High Speed.—Driving a car around a sharp corner at twenty-five miles an hour does more damage to the tires than does fifteen or twenty-five miles of straight road work. This is an economical reason why one should drive around corners cautiously and slowly. The other reasons are obvious.

Using the Motor as a Brake.—The engine is a natural brake whenever the throttle is closed. Prove this for yourself in the following way. At a speed of twenty miles an hour, close the throttle and retard the spark, at a certain mark by the roadside, telegraph pole, for example. Don't throw out the clutch or the motor will have no braking effect. Now note how far you have traveled from the pole by the time your speedometer registers five miles. Then over the same road and at the same speed (20 m. p. h.) pass the pole again, but this time throw out the clutch. You will coast much farther this time before you drop down to five miles. Note the difference between this last mark and the first. This distance is proportional to the work done by the motor as a brake. By the same token the wear on your brakes will be lessened in this proportion if you let the motor help. In short, never throw your clutch out until you have dropped down to the lowest speed at which the car will run, say two or four miles an hour. If the grade is long and steep, use the foot and emergency brakes alternately. This equalizes the wear on them.

A Car's Service Depends Upon the Driver.—Much of the satisfaction that an automobile gives depends upon the driver. If he neglects his automobile, if he does not lubricate it, or if he tinkers with it too much, he is bound to receive unsatisfac-

tory service. No machine can be absolutely automatic. All things must wear in time. The best preventive of wear, and the most certain thing for increasing the life of an automobile, is proper lubrication.

Familiarize yourself thoroughly with all the lubricating points of your car. The oiling chart, Fig. 25, will show you where the important ones are located on most cars. Make the lubrication of your car as regular as is the eating of your meals. If you do this, you will not have any complaint to make of your car becoming noisy or of bearings wearing out. If you don't do it, you will not get the satisfaction from your car that you have expected.

Coasting Mountain Roads.—Whenever you approach a long and steep grade it is best to put down the gear speed lever into first speed and allow the car to drift down on the motor. This is better than using the brakes. It gives you absolute control of the car at all times.

Know Your Car.—Your satisfaction will be greatly increased if you will learn the details of your automobile. Learn to make the simple adjustments. Do not depend upon some one else to do that which is so simply done and which you can get such satisfaction in doing. There are no inaccessible parts that should interfere with ready adjustments. Familiarize yourself with every detail of the car as it is explained in this book and you will have greater confidence in venturing over any road at any distance from a repair station.

The Cost of Speed.—The law is just as immutable in that it collects as great cost for speed in a motor car as it does of any machine or of man. If you run fast, if you work hard, you require more food to sustain you. If you drive your car at a fast speed all the time, it requires more fuel—more gasoline and more oil. If you work fast and hard, you wear out more quickly, and so does an automobile. Tires, for instance, last twice as long on a car that is driven at fifteen miles an hour as they do upon cars that are driven at thirty miles an hour. Remember that the service your car gives you is as much dependent upon the manner in which you operate it as is your

own health dependent upon the manner in which you care for it.

Use of Headlights.—Do not use the electric headlights turned to the "bright" position when approaching or passing a car or other vehicle on a narrow road, unless you are traveling in the same direction. The light confuses them and may result in a serious accident. Never use a "spot light" except when necessary for reading signs, etc.

To Keep Water from Clinging to Windshield.—If you are in a climate where snow and sleet are a common feature of the weather, for any lengthy period, you can keep the windshield clean by wiping it over with a solution of water, glycerine and salt. The proportions are:

1 oz. water
2 ozs. glycerine
1 dram salt

Pour this on a piece of gauze and wipe the glass with all the strokes down. This will prevent raindrops or water in any form clinging to the glass.

Carry a Complete Tool Equipment.—By all means have the necessary tools at hand to meet an emergency; even though you do not need them yourself, there is a certain amount of satisfaction in knowing that you are equipped to help a fellow motorist who is less careful in this respect. In changing a tire, a jack, pump, wrench, pliers, and sometimes a hammer, are necessities. If you do not have them with you, it may necessitate running many miles on the rim, ruining a good casing, damaging the rim, and perhaps loosening up the spokes in the wheel. Carry the tools in the tool roll supplied with the car, and wrap the jack and other tire tools in clean rags to prevent them rattling. A little oil should be rubbed on them occasionally to prevent rusting. It will often save soiling your gloves through handling dirty tools. If you are carrying spare tubes, keep them away from any grease and oil, which will injure the rubber. Do not pack them with the jack and other tools that are liable to chafe or cut them. Put them in bags, properly deflated and folded and covered with talc to prevent chafing. Tools for repairing mechanism and tires are described in Chapter IV.

THINGS TO REMEMBER

Don't attempt to start the engine with the switch turned off or without gasoline in the tank.

Don't fill the lubricator in the engine, and neglect to lubricate all other parts of the car.

Don't neglect the lubrication of any part of the car.

Don't advance the spark when starting the engine.

Don't allow the clutch to engage suddenly.

Don't apply the brakes suddenly unless absolutely necessary.

Don't neglect to inspect the level of the acid in the storage battery, at least every two weeks, and supply distilled water if needed.

Don't neglect to keep the radiator filled with water, or with a good anti-freezing solution in cold weather.

Don't attempt to shift reverse gear when the car is moving ahead.

Don't attempt to shift from third to second or first gear when car is running at a high rate of speed.

Don't attempt to shift from second to first gear unless the car is running very slowly.

Don't neglect to investigate any unusual sound which may develop in the car.

Don't drive fast or attempt to stop suddenly on wet pavement.

Don't neglect to keep the tires properly inflated.

Don't release clutch when the throttle is open very wide.

Don't let every Tom, Dick and Harry drive your car.

Don't let every mechanic, or so-called repair man, make you believe that he knows more about the way the car ought to be built than the manufacturer.

Don't use the starter to run the car. The excessive overload on the battery is very injurious.

Don't blame the starter when the engine doesn't start—look in the gasoline tank.

Don't push in starting button when engine is running.

Don't forget that using the starter a certain number of times will exhaust the supply of current in the battery, unless the engine is run sufficiently to recharge it.

Don't allow your car to stand in puddles of oil or water, as neither one is good for your tires.

Remember that the pan, engine and other mechanical parts of the car should be kept clean.

Don't turn corners too fast. While this may seem spectacular, it is always hard on tires.

Never open the throttle too quickly, but give the motor a chance to pick up gradually.

Keep your brakes adjusted.

Familiarize yourself with the use of the hand lever brake and thus be prepared for emergencies.

Be sure to release the clutch before shifting gears.

Don't accelerate too quickly; this causes the car to jump and the motor to pound.

Examine the car occasionally for loose nuts and bolts.

Don't race your engine under any circumstances.

Remember that a squeak from the car means oil needed.

Never take your car out until you are sure it is properly lubricated.

Be sure your brakes are released before attempting to move car.

When you undertake to make any adjustments on your car, be sure you are right, then go ahead.

Never fold the top back when it is wet, as this will cause it to deteriorate rapidly.

Don't let your engine labor going up a steep hill; drop back to a lower gear if necessary.

Don't fail to cover the radiator and hood with a blanket or robe when the car is left standing in the cold. This keeps much of the heat in the cooling system and facilitates the starting of the motor.

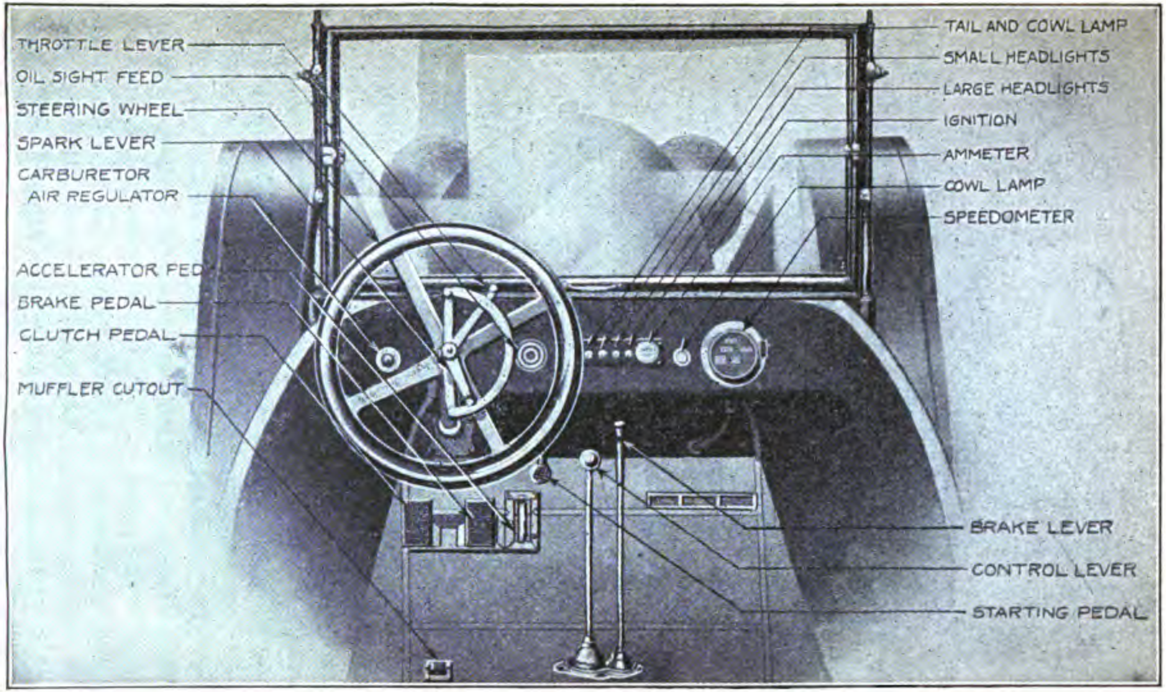


Fig. 36.—Control System of the Buick Light Six Automobile.

CHAPTER III

TYPICAL 1917 CONTROL SYSTEMS

Points of Similarity—How to Discover Proper Lever Position—General Control Hints—Buick—Cadillac Eight—Chalmers—Cole Eight—Dort—Dodge Brothers—Empire—Ford Model "T"—Haynes—Hupmobile—Hudson Super Six—Hollier—King Eight—Kissel Kar—Maxwell—Marmon—Mitchell—National—Oakland Model 32—Oakland Model 50—Overland 75—Overland 85—Packard Twin Six—Paige—Pierce-Arrow—Reo—Stearns-Knight—Studebaker—Scripps-Booth—Velie.

IT must be evident to the reader that it would be extremely difficult to outline the control systems of all the automobiles at the present time because there are so many different makes which vary from each other in matters of minor detail. Fortunately, practically all cars have almost the same method of controlling the engine speed, changing the gear ratio and controlling the brake and clutch. The steering of all cars is accomplished by means of a hand wheel carried on an inclined steering column in front of the driver. The spark and throttle levers which are used to vary the engine speed are either carried above the steering wheel, at the top of the column, or are mounted immediately beneath it, one on each side of the steering post. Clutch and brake pedals have the same location in practically all cars. As a general thing the left pedal actuates the clutch and the right pedal the foot brakes. An additional means of regulating engine speed called the "accelerator" is usually placed close to the brake pedal so that it can be easily operated by the right foot. The gears are shifted by a handle, placed at the center of the car and intended to be operated by the driver's right hand, on most automobiles. As sliding gears, used for changing vehicle speed, are operated on the selective system, there are many cars in which the change speed lever works the

same way. The emergency brake actuating handle is almost invariably carried at the side of the gear shift lever, though in some cars, notably the Chevrolet, Dort and Reo, the emergency brakes are operated by a foot pedal placed the same as the service brake pedal of most cars, while the service brake is actuated from the clutch pedal. There are a number of details which differ in the various cars, but these can be easily determined by a little study on the part of the motorist.

How to Discover Proper Lever Position.—In most cars where the spark and throttle levers are placed above the steering wheel, it is usually the function of the shorter one of the two, which is always the upper one, working against the inside of the quadrant, to regulate the spark timing; while the longer one, which works against the outside of the quadrant, and which is the lower lever, regulates the carburetor throttle. In nearly all cars a movement of a longer lever that opens the throttle can be determined by raising the hood and watching the movement of the throttle lever on the carburetor. When the throttle is closed the carburetor throttle lever will rest against a stop screw. The position of the long lever on the steering wheel will then be noted. It will be at one extreme or the other of the quadrant. In most cars the lever is pushed away from the driver to increase the speed of the engine, though in some the movement is directly opposite and the lever is pulled toward the driver. It is general practice to have the spark lever work in the same direction as that controlling the carburetor throttle. The same movement that closes the throttle will retard the spark if the upper lever is used. For example, if the carburetor throttle is fully closed when the lever is near the operator a similar placing of the spark control member will insure a retarded spark.

Most hand brake levers are designed to be worked by a pull, i. e., the brakes are released when the lever is in its extreme forward position and are applied when it is pulled back as far as it can go. There are two systems of shifting the change speed lever. That known as the "cane" shift involves moving the lever without any guiding quadrant. The "gate" shift is the type in which slots are provided in a guiding member to assist

the driver in locating the speed shifter. Most cars that have the selective gate have the various speeds clearly indicated by means of lettering and numbers. The letter *R* indicates the position for reverse motion of the car. The numeral 1 indicates low speed; 2 shows the proper lever placing for intermediate speeds, while 3 indicates the higher speed or direct drive position. Cars using more than three speeds have an additional slot in the quadrant used only for reverse. The "cane" shift is used only with cars having three speeds forward and a reverse.

It is not difficult to discover the proper lever placing to obtain the different speeds if these are not indicated. After the engine is started, if the clutch is released the gear lever may be placed in any position the driver desires. The engine is speeded up a little and the clutch is engaged very gradually. If the car starts smoothly and without appreciably diminishing the engine speed it is evident that the low speed gear has been engaged. The other extreme position of the lever on that side of the quadrant is practically always the reverse. Similarly if when the clutch was engaged the car started to go backward, the fact that the reverse gears had been meshed would be self-evident. If when the clutch is engaged the car starts forward but almost stalls the motor, the change speed lever has been put into the intermediate gear position. If the engine stops or "stalls" when the clutch is engaged, the gear shift lever has been put in the high speed or direct drive.

In most cars the low speed and high speed are obtained by moving the lever in the same direction, though of course at different sides of the quadrant, or by rocking it to opposite sides of the center. The reverse and intermediate speed positions are usually on the same line, the reverse speed position being on the same side of the car as the slow speed while the intermediate is invariably on the same side as the high speed. When experimenting in this way it is well to have one foot ready for the brake and one on the clutch, so that it may be released immediately if the proper speed ratio has not been engaged. The reason why the low speed and reverse are obtained at one side of the quadrant while the intermediate and high speeds are

obtained at the other is because as gear boxes are ordinarily constructed the shifting member that gives the low and reverse speed is shifted by one fork while that that moves to give the intermediate or high speed is operated by another shifting fork. The various movements of the change speed gear members necessary to obtain the various speed ratios are very clearly shown in Figs. 30 to 34, inclusive.

GENERAL CONTROL HINTS

Buick.—The driver's compartment of the Buick Light Six is clearly shown at Fig. 36. The position of the various control elements are clearly indicated and can be readily identified. Before starting the Buick motor see that the ball top control lever stands in a neutral position where it is free to move sideways. The spark and throttle levers on the steering wheel are moved about one third of the way down on the sector. The switchboard is unlocked so the keys can be shifted and the button marked "Ign." is pulled out. The air regulator or choke button is pulled out and starting pedal is pressed with the foot. This starts the electric motor and turns the engine crankshaft over. If motor does not start in a half minute, release the starting pedal and examine the various control members to see if they are properly set. Then depress the starting pedal again. In ordinary weather the motor should start readily, but in very cold weather the engine is apt to start hard, especially if the car has been standing some days. As soon as the motor starts, push the air regulator button, which is at the extreme left of the cowl board, half way in and leave it in that position until the motor is thoroughly warmed up. When the motor has been run for some minutes, the air regulator button may be pushed all the way in. It is stated that the motor should not be run for any length of time with the air regulator button pulled clear out because this produces an excessively rich mixture. Pull the spark lever down as far as it will go on the sector, as the automatic spark advance feature of the igniter will take care of spark timing for all ordinary driving. Close the throttle lever on the steering wheel until the motor runs slowly and yet

without misfiring. The foot accelerator can be used to control the speed of the motor.

Now that the motor has been started it is possible to set the car in motion. The first step is to release the emergency brake lever by pulling it back enough so that the thumb button on top can be depressed, this unlocking the ratchet, and then push the lever as far forward as it will go. Place the left foot on the clutch pedal, press it down firmly and keep it in this position, then with the right hand move the control lever over to the right and then pull it back. This puts the gears in the low speed position. Press lightly on the accelerator pedal to increase the speed of the motor and let the clutch in gradually by releasing the pressure of the left foot on the clutch pedal. Increase the speed of the motor until the car gains headway. When the car has acquired sufficient momentum, disengage the clutch again, and let up on the accelerator pedal. With the right hand shift the control lever forward to the neutral position, then over to the left of the car and then forward again as far as it will go. This gives the intermediate speed. The next step is to shift into the high speed or direct drive. This is done by depressing the clutch pedal and pulling the change speed gear lever as far back as it will go. The speed of the car can be controlled entirely by the use of the accelerator pedal. If it had been desired to obtain reverse speed, instead of having pulled the gear shift lever back after it had been shifted over to the right it would have been pushed forward. When a car has been moving forward, it is always necessary to bring the car to a full stop before putting the change speed lever in the reverse position.

Cadillac Eight.—The control system elements of the Cadillac "Type 53," as well as the instruments on the cowl board, are clearly outlined at Fig. 37. Before starting the engine the transmission control lever should be in neutral position and the hand brake applied. Note the pressure of air in the gasoline tank, which is indicated by an air pressure gage carried on the dash. If the pressure is less than one pound, it should be increased to that pressure by means of a hand operated air pump which

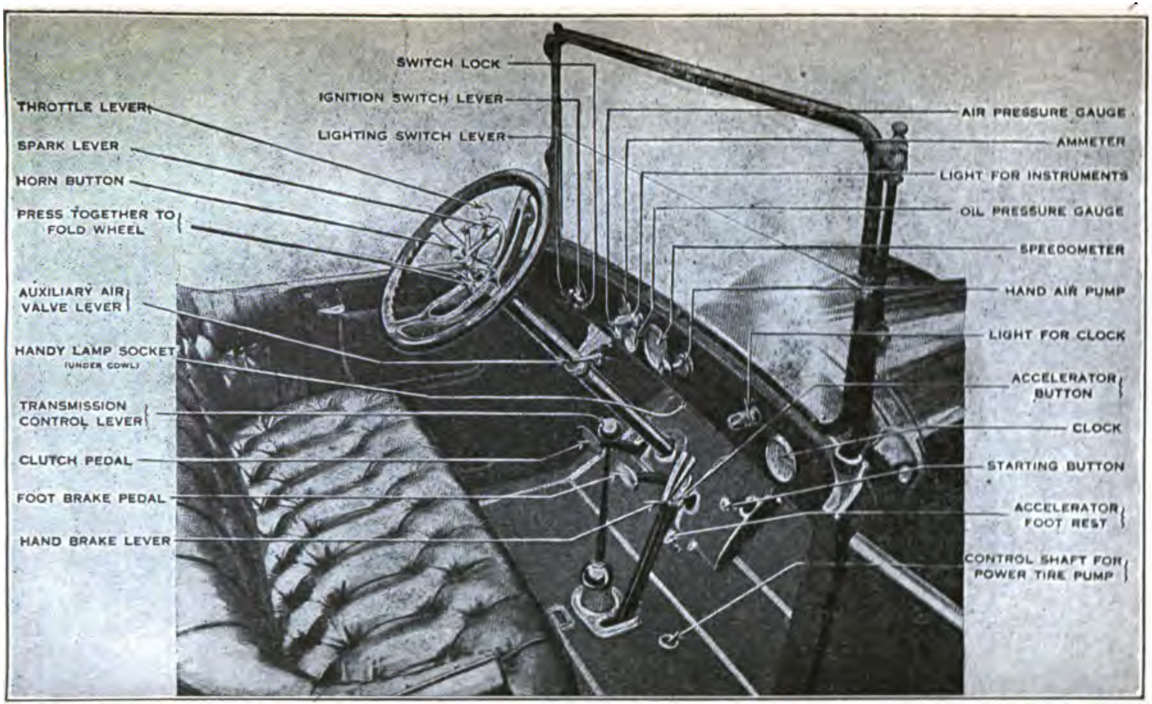


Fig. 37.—Control Group of the Cadillac Eight Cylinder Automobile.

is placed alongside of the speedometer. After the engine is started, pressure is automatically maintained by a power pump driven from the engine. Place the spark lever at the right of the sector and the throttle lever about two inches from the extreme left. Move the ignition switch lever down to switch on the ignition. The ignition and lighting switch is carried at the extreme left of the dash. Depress the starting button with the foot, to turn over the engine. If the engine has been standing for some time in warm weather, and practically always in cold weather, pull up the auxiliary air valve lever which is carried on the steering column brake in order to choke the air passage to insure positive start before the starting button is pushed down. As soon as the engine fires and runs under its own power the pressure should be released from the starting button. The auxiliary air valve lever is pushed down half way as soon as the engine is started, and all the way down as soon as the engine is warm enough to permit doing so.

Whenever the engine is cranked by hand, the spark lever should always be placed at the extreme left of the sector in order to retard the spark. Never press in the starter button while the engine is running. Before starting the car the hand lever should be released by pushing it to its extreme forward position. The same rule for speeding up the engine, declutching before shifting the gear lever, letting in the clutch gradually and obtaining sufficient momentum before shifting from higher to lower gears, previously given, should be followed in all cases. This car also employs the "cane" shift, and when the transmission control lever is in neutral it is standing approximately vertical and can be easily rocked from side to side. To obtain low speed the lever is moved as far as possible over to the left and then pulled back as far as it will go. If the lever is moved to the left and pushed forward it will engage the reverse speed. To obtain the intermediate, the lever is pushed over to the right from the neutral position and as far forward as it will go. To obtain high speed the lever is rocked to the right and pulled back.

Chalmers Six.—The driver's compartment of this car, with

all control elements plainly designated, is shown at Fig. 38. In this the lighting and ignition switch is carried at the side of the steering column and below the steering wheel. The spark control lever is the short one on the top of the column, while the throttle lever is the longer one. The starter button is conveniently placed so it can be operated by the heel. Two levers

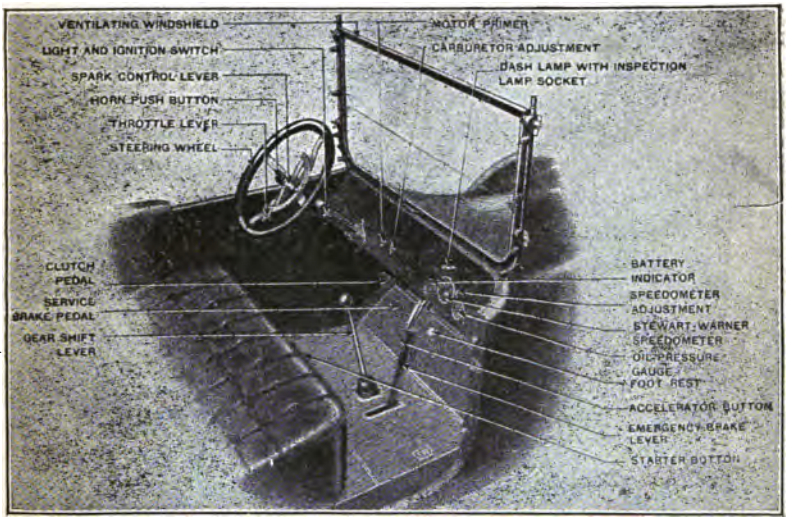
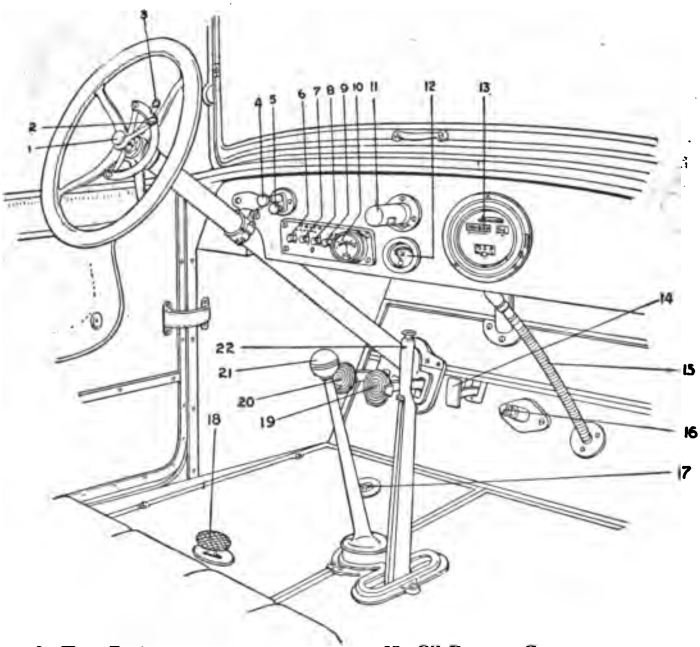


Fig. 38.—How Chalmers Light Six is Controlled.

are approximately in the center of the cowl board, one of these being a motor primer, the other a carburetor adjustment. At the right of the dash board is a group consisting of an oil pressure gage, a speedometer, ampere meter and dash lamp. An accelerator button is provided so the engine speed may be controlled independently of the throttle lever. The gear shift is of the "cane" type, while the clutch and service brake pedals are arranged in conventional manner. To start the engine it is necessary to prime the carburetor and set the carburetor adjustment for a rich mixture. The spark lever is advanced about half way up on the segment and the throttle is also open about the same amount. Then turn on the ignition switch, make

ıre the gear shift lever is in neutral and push down the starter utton on the floor with the heel. As soon as the motor starts ıe pressure on the starter button is relieved and the spark and ırottle levers are set so the motor idles quietly. The spark ever is left about two thirds advanced on the quadrant, while ıe throttle lever is pulled back toward the driver to a point here the engine does not race. If the engine does not run moothly, the dash carburetor adjustment lever should be ma-



1—Horn Button
2—Spark Control Lever
3—Hand Throttle
4—Carburetor Adjustment Button
5—Choker for Starting
6—Dimmer
7—Headlight
8—Tail and Dash Light
9—Ignition
10—Ammeter
11—Dash and Service Lamp
12—Oil Pressure Gauge
13—Speedometer
14—Accelerator Pedal
15—Speedometer Drive Shaft
16—Starting Motor Button
17—Tire Pump Lever
18—Muffler Cut-out
19—Foot Brake Pedal
20—Clutch Pedal
21—Gear Shift Lever
22—Emergency Brake Lever

Fig. 39.—Control System of Cole Eight With All Parts Clearly Indicated.

nipulated until the engine runs regularly. The operation of the clutch and gear shift levers follow conventional practice. The gear shift lever is moved toward the left and back toward the operator for the low speed. It is moved to the left and away from the operator to secure reverse motion. Moving the lever over to the right and pushing it forward gives the intermediate speed. Moving the lever from the intermediate speed back toward the operator will give the high gear. The spark is retarded and throttle is closed when the levers are pulled back toward the operator. The emergency brake is applied by pulling the lever back, and released by pushing it forward.

Cole Eight.—The control group of the Cole eight-cylinder automobile, with all parts clearly indicated by numbers and a key giving the names of the various parts, is presented at Fig. 39. The first step in starting the engine is to pull the carburetor adjustment button on cowl board out half way. This is indicated as No. 4. Next pull the choker, No. 5, out all the way. Pull the throttle lever, which is No. 3, or the long one on top of the steering gear, down about two inches. Next move the spark control lever, which is the short one, or No. 2, down about one third of its travel. Bear in mind that the lever should always be in full retard position or at the top of the quadrant for hand cranking. Next unlock the ignition switch on the cowl board with a key provided for that purpose. Pull out button marked "Ign." on the switch, which is designated as No. 10 in the illustration. Next depress starting switch button in center of the board with the right foot. As soon as the motor starts, release the starting button, push the carburetor chock button all the way in and move No. 4 adjustment button into the point where the engine runs regularly. Release the hand brake and the car is ready to start. With this transmission, the gear shift lever is pushed to the right, and forward, to obtain low speed, and to the right and back for reverse. Moving the lever over to the left and forward engages the high speed; while pulling it back, when in the right-hand position, gives the intermediate speed.

Dort.—As will be evident by referring to Fig. 40, the Dort

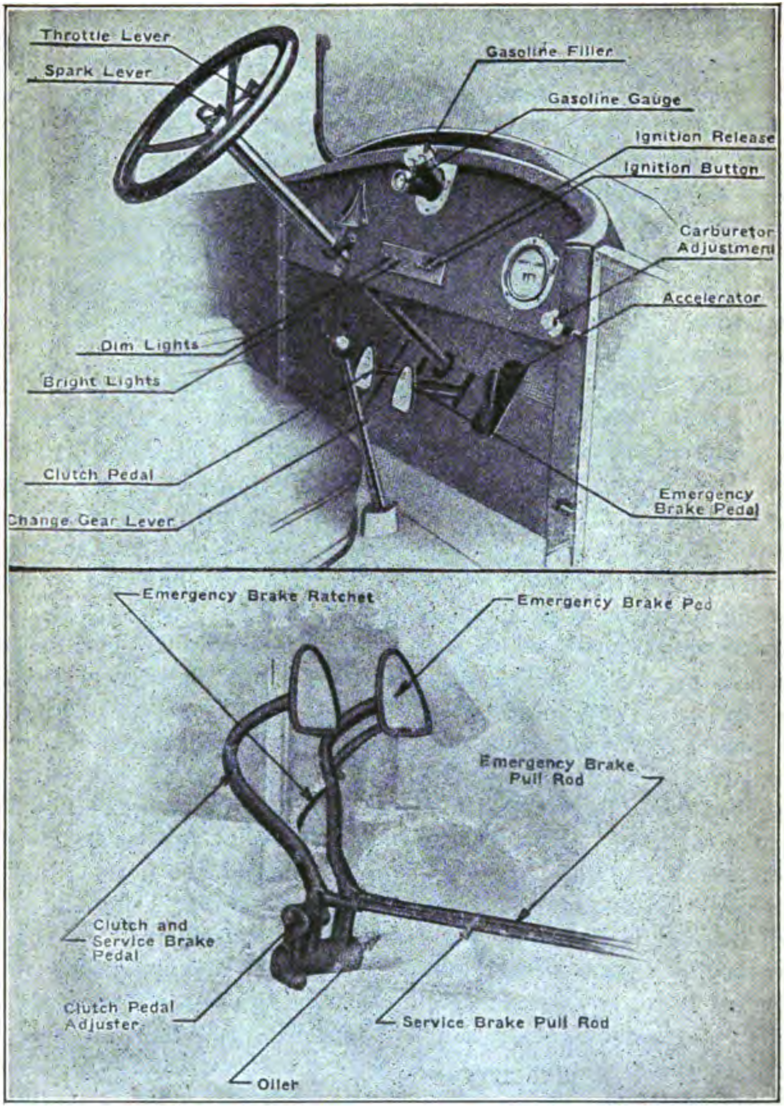


Fig. 40.—Dort Cars Have a Simple Control System in Which Only One Hand Lever is Used. The Clutch Pedal Applies the Service Brake After Clutch is Released.

car has that type of control in which but one hand lever is provided. The clutch pedal serves to apply the service brake, while the pedal that is ordinarily used for the service brakes applies the emergency brake action. The cowl board has a carburetor adjustment at the extreme right and a simple type of switch having four buttons. One of these is used for dim light control, the other the bright lights. There are two buttons in the ignition part of the switch, one to apply, the other to release the switch. Spark and throttle levers are provided at the top of the steering column, the short one being the spark control, while the longer one regulates the throttle. The closed position is when the lever is at the extreme top. Before starting the car, advance the spark lever about half way and open the throttle by moving the throttle lever about an inch from the topmost position. This will open the carburetor sufficiently to start the motor. The next step is to pull out the carburetor adjustment or "choke," then to close the ignition circuit by pushing in the proper button on the ignition switch, after which the left heel is placed on the starter button to turn the engine over. It will not be necessary to use the choke in warm weather, but it will be advisable to pull it way out when trying to start the engine in cold weather. As soon as the engine starts, release the starting switch and close the throttle to the point where the engine will run smoothly. To release the emergency brake, press a little heavier at the bottom of the pedal pad than at the top to release the ratchet and allow the pedal to come back to normal position. As the left pedal operates the clutch and the service brake as well, if this is its normal position the clutch will be engaged. A movement of two or three inches releases the clutch and a further movement applies the service brake. To obtain various speed changes, the shift lever is moved to the left and pulled back for slow speed, and moved to the left and pushed forward for reverse. To obtain second speed, the lever is pushed over to the right from the neutral position and moved forward. The direct drive or high speed is obtained by pulling the lever straight back from the second speed position.

Dodge Bros.—The arrangement of the control parts of the

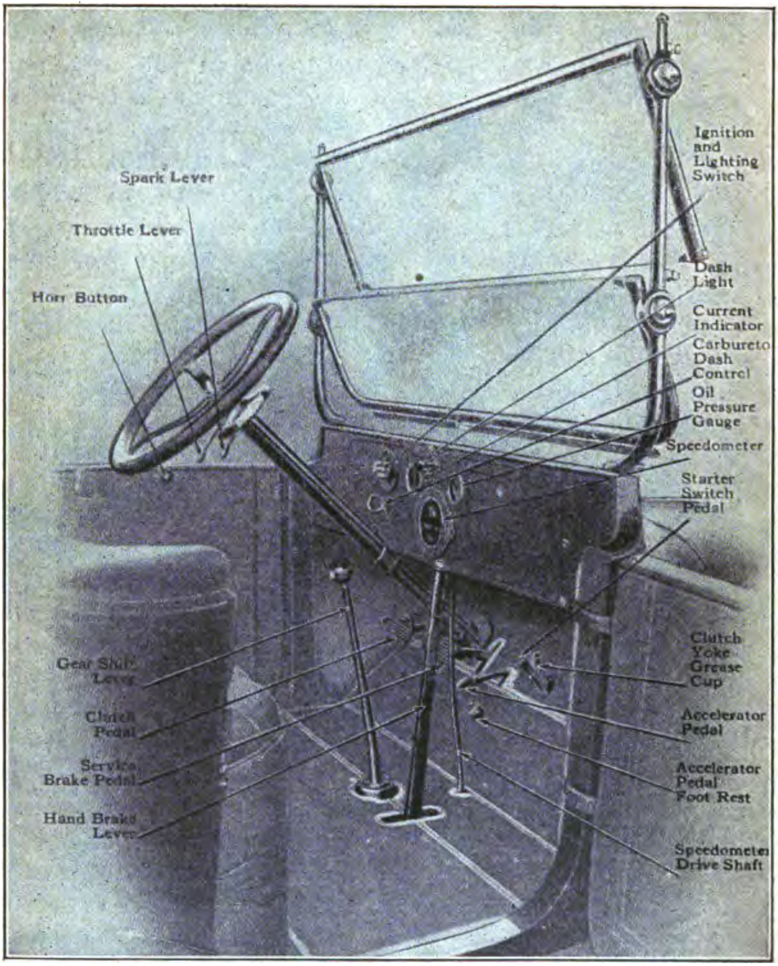


Fig. 41.—Dodge Brothers Motor Car Control System.

Dodge Bros. car, as given at Fig. 41, follow conventional practice for the most part. In this the spark and throttle levers are carried below the steering wheel and at the right side of the steering column. The top lever controls the throttle and the lower one the spark. A combination ignition and lighting switch

is placed at the extreme left of the cowl board and immediat below it is the carburetor "choke" control. The instructic previously given for starting the other cars apply just as w to this one. The spark is retarded when the short lever on t steering column is pulled as far back toward the operator it will go. The throttle lever is in the closed position when is at the retard end of the sector. The gear shift lever is mov

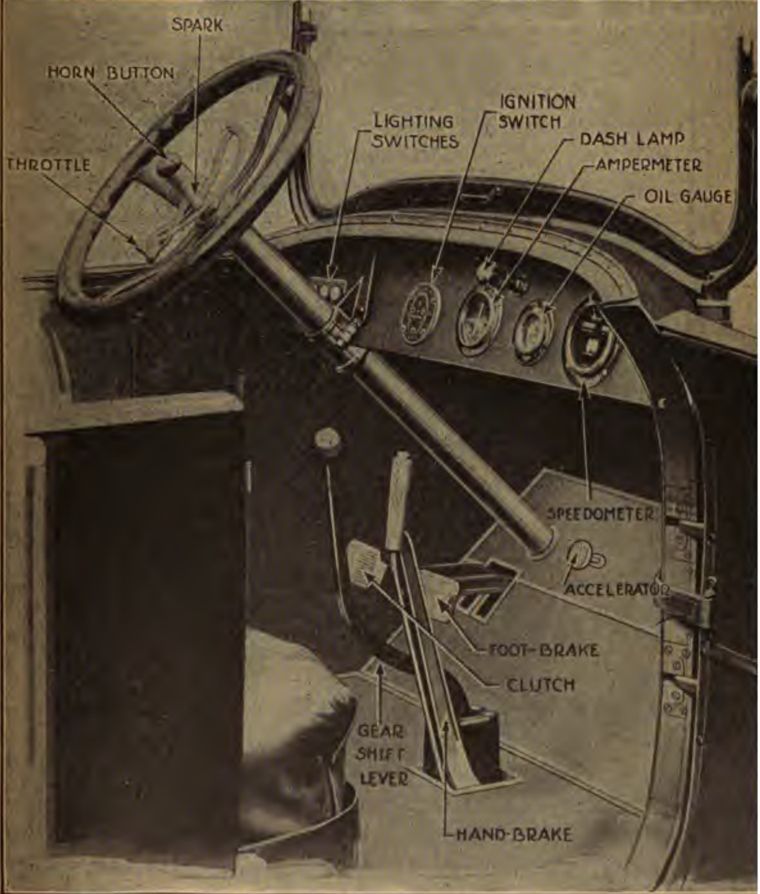


Fig. 42.—Control Group and Dash Assembly of the Empire Model 6

to the left and forward to obtain the slow speed, and to the left and back for reverse; moving it over to the right and pulling it back gives the intermediate speed, while moving to the right and forward engages the direct drive gears.

Empire.—The driver's compartment of the Empire Model 60 is clearly outlined at Fig. 42, this being lettered to show the various parts of the control system very clearly. In this car the spark and throttle levers are carried above the steering wheel and at the top of the steering column. The lighting switch is placed at the extreme left of the cowl board. The first member to the right of the steering column on the cowl board is the ignition switch, this being followed by the ampere meter, dash lamp, oil gage and the speedometer. The latter is at the extreme right. In this car the spark and throttle levers are moved away from the driver to advance the spark and open the throttle. Before starting the motor, the hand throttle and spark levers on the steering wheel should be set about one third of the way up. Next unlock the ignition switch and push in the left-hand button. Pull out the air regulator plunger and press the starting button as far as possible. The starting button is placed in the center of the dash, just above the floor boards. After releasing the clutch, the control lever should be shifted to the left with the right hand and pulled back. This engages the slow speed. Sometimes it happens that the gears in the gear box are so lined up that they will not mesh. If there is any difficulty in securing proper engagement, push the control lever back into neutral position, let the clutch back in and allow the motor to turn for a few seconds. Repeat the operation as before, throwing out the clutch pedal and pulling the gear shift lever over to the left and then back. To change the second speed, push the control lever to the right, after passing through neutral, and then as far forward as possible. The high speed is on the same side as the intermediate and opposite it. Similarly, the reverse is opposite the low speed and on the same side.

Ford Model T.—The Ford car is one of the most popular of the moderate-priced automobiles, and over 1,000,000 of the Model T are now on the road. The control system of this car

is extremely simple, and yet it is different from that of any other automobile. The gearset, which is found only on this car, is a planetary type which gives two forward speeds and a reverse motion. The conventional form of steering wheel is used to control the direction of car travel, and spark and throttle levers are mounted on the steering column beneath the wheel to control

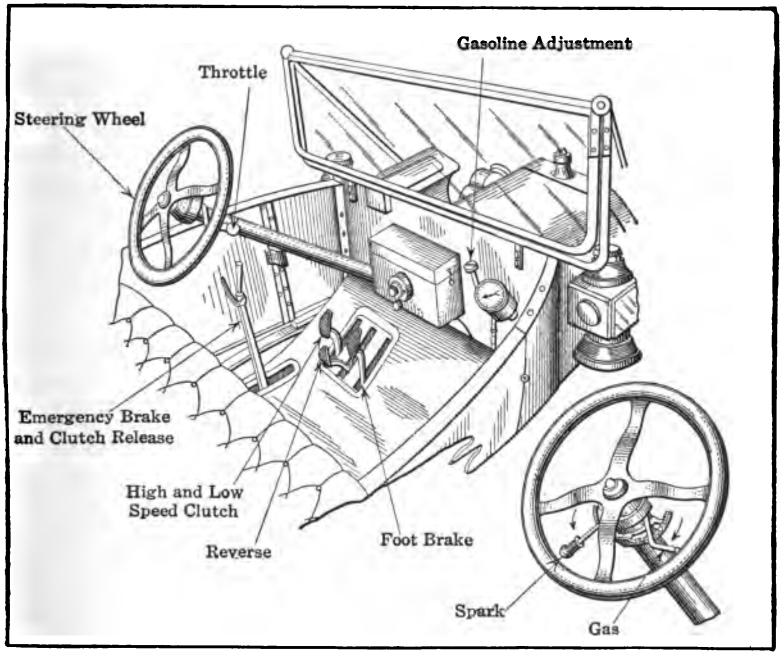


Fig. 43.—The Distinctive Control System of the Ford Planetary Transmission Used on Model T Cars.

the speed of the power plant. No accelerator pedal is ordinarily provided. It is in the method of obtaining the various speed ratios that the control system is distinctive. As will be seen by referring to Fig. 43, three pedals and a hand lever are provided on the left side of the car. The pedal on the extreme left is used to control the high and low speed clutches and is marked *C*. That next to it, which is marked *R*, is used to constrict the reverse band of the transmission and obtain reverse

motion. The pedal at the right, which is provided with a letter *B* cast on its surface, is used to apply the foot brake.

The hand lever engages the high speed or direct drive clutch when thrown forward, and when pulled back it actuates the emergency brake. An interlocking connection is provided so the emergency brake cannot be applied without releasing the direct drive clutch. The lever may be set in a neutral position and the clutch will be released without applying the brake when it is approximately vertical. When the high speed is in and the hand lever is thrown way forward, the high-speed clutch may be released by a light pressure on pedal *C*, and a further movement of this pedal will apply the low speed. Thus one pedal gives control of both high and low speeds forward, and the clutch can be released in exactly the same manner as that of a sliding gear car when it is desired to slow up, such as for turning a corner, descending a hill or passing another vehicle.

Before starting the car the hand lever must be in a vertical position, this releasing the clutch and applying the emergency brakes. To start the car, after the engine has been started in the usual manner, the foot is placed on the clutch pedal to keep it in a neutral position, while the hand lever is thrown as far forward as it will go. The engine is then accelerated and the clutch pedal is pushed forward until the slow-speed band tightens around the drum of the transmission and the car gathers headway on the lower ratio. After it has attained a certain momentum, the clutch pedal is allowed to drop back gradually into the high-speed position. The foot may then be removed until such times that the clutch must be disconnected. Before applying the foot brake, which is done by pressing with the right foot upon the pedal marked *B*, the clutch pedal should be put in neutral position with the left foot.

To reverse the car, it must be brought to a standstill. The engine is kept running and the clutch is disengaged with the hand lever, which is placed in the neutral position but not pulled far enough back to apply the emergency brake. The reverse pedal, marked *R*, is then pushed forward with the left foot, leaving the right one free to use on the brake pedal as needed.

To stop the car, the throttle is closed so that the engine will not race; the high speed is released by pressing the clutch pedal forward into its neutral position and applying the foot brake slowly, but firmly, until the forward motion of the car is arrested. It is imperative that the foot be retained on the clutch pedal until the hand lever is pulled back to its neutral position.

The placing of the spark and throttle levers is clearly shown in the inset in the right-hand corner of the cut, both levers being pulled back to accelerate the motor and pushed forward to slow it down. The same rules previously given for the manipulation of the spark and throttle levers apply just as well to this make of car. As no accelerator is furnished on stock cars, all carburetor control is by the throttle lever. No self-starter is provided, so the engine must be started with a hand crank as previously described.

Haynes.—The control parts of the Haynes car are shown at

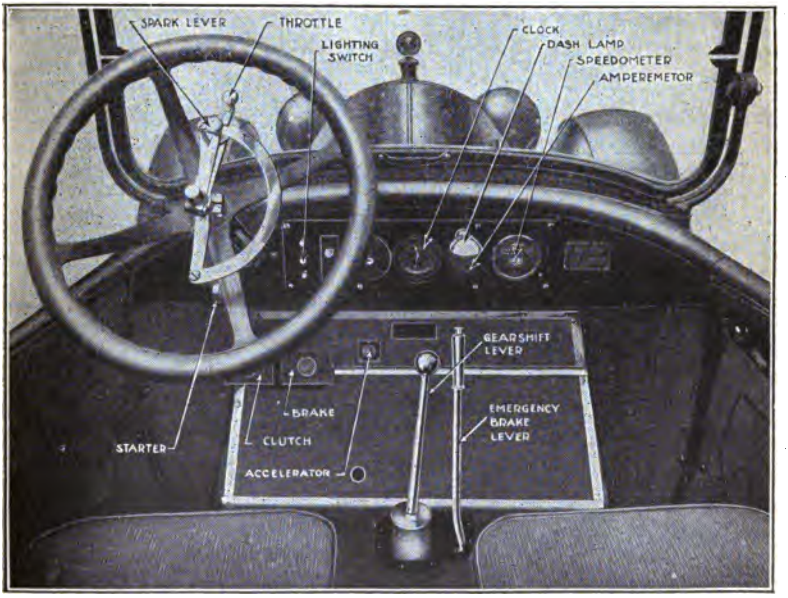


Fig. 44.—Control Group and Dash Assembly of the Haynes Automobile.

Fig. 44. In this the spark and throttle levers are mounted above the steering column. The remainder of the control units also follow conventional practice. The spark and throttle are moved toward the driver to speed up the engine. When in the position shown the spark is retarded and the throttle closed. The first step in starting the engine is to bring the throttle lever down about two inches from the top of the quadrant and the spark lever about three inches down. Next turn the ignition switch so the arrowhead points to *On*. Pull out the ring on the cowl board under the steering wheel. As soon as the engine starts, release the ring and never hold it out for more than ten or fifteen seconds if the engine fails to start. If the weather is cool, pull out the carburetor priming button, which is at the left side of the steering column. This should be held out for at least fifteen seconds. To stop the engine, turn the ignition switch to the center position. Be sure that the switch is always turned *Off* if the engine is not running, because if it is allowed to stay on for any length of time the storage battery will run down so it will not furnish current enough to crank the engine. For this reason, on this car, practice should be made of always locking the switch when the engine stops and of taking out the key. The gear shift lever is moved to the left and back to obtain first speed, and to the left and forward for reverse. The second speed is obtained when the lever is in a right forward position, and the high speed in the right rear position.

Hupmobile.—The control system of the Hupmobile Series N is shown at Fig. 45. The carburetor air control is placed on the side of the steering column, the lighting switch is at the left of the speedometer, while the ignition switch is at the right of that member. Clutch and brake pedals are arranged in the usual manner. The spark lever and throttle are moved away from the driver to speed up the engine. Before starting the engine, it is necessary to set the spark and throttle levers as previously recommended and to pull up on the carburetor air control. The ignition switch is then put in the *On* position and the starting pedal depressed in the usual manner. The emergency brake is applied by pulling the hand lever back toward the operator. The gear

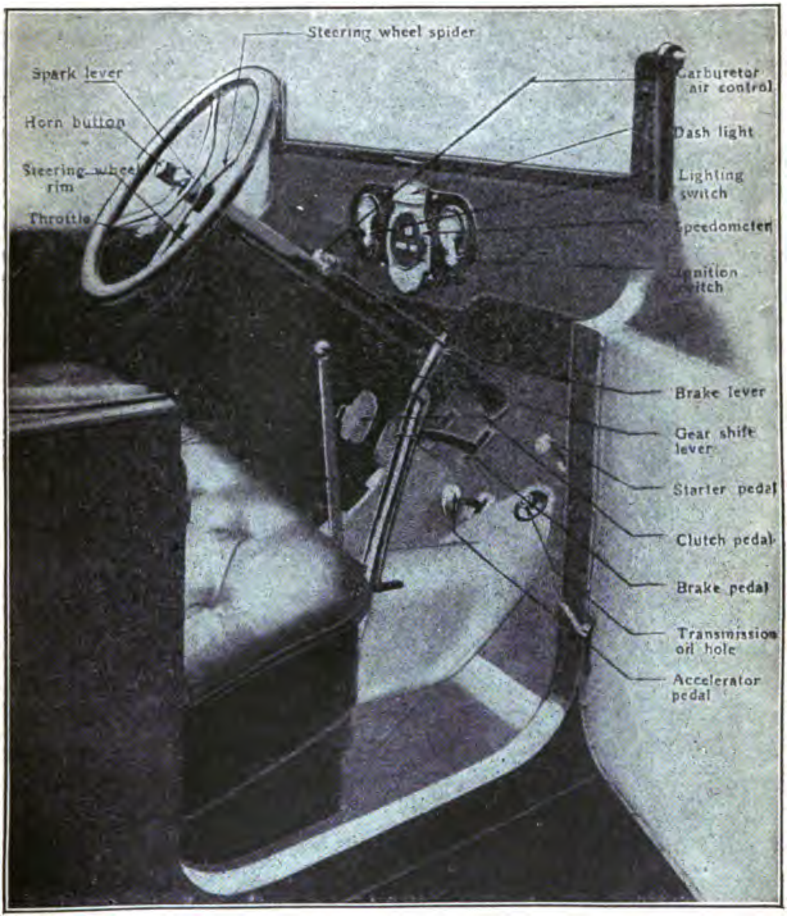


Fig. 45.—Hupmobile Model N Control Group.

shift lever is in neutral when it stands approximately vertical. To obtain the low speed, the lever is moved over to the right and the hole in the lever is engaged with the pin that projects just below the top of the slot. Pulling the lever back on the right-hand side engages the reverse speed. Pushing it forward on the left-hand side gives the slow speed. The second or intermediate speed is obtained by pushing the lever over to the left

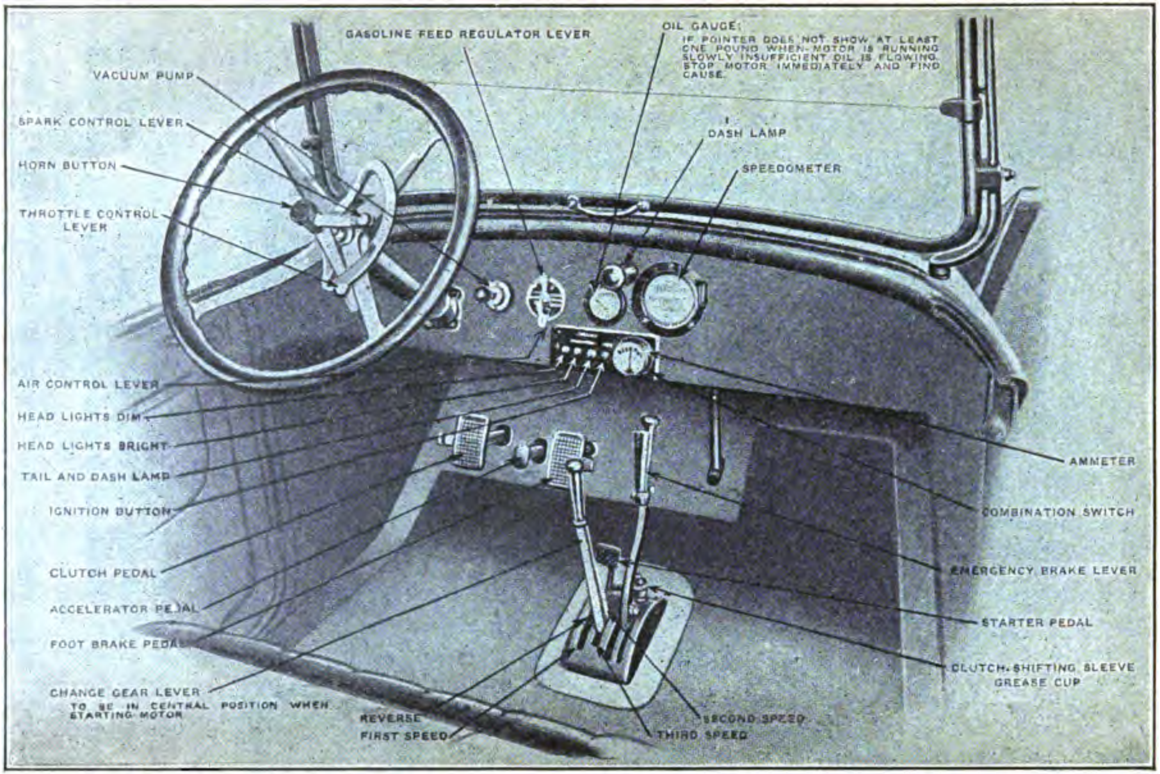


Fig. 46.—Control Levers and Dash Assemblies of Hudson Super-Six.

and moving it back. The high speed ratio is secured when the lever is moved to the right and pushed toward the front of the car.

Hudson Super-Six.—The driver's compartment of the Hudson Super-Six is shown at Fig. 46. The arrangement of the parts follows conventional practice. A special carburetor regulating fitting is carried on the dash just above the ignition and lighting switch and to the left of the oil gage. This has one lever at the top, which regulates the gasoline feed, and one at the bottom, which controls the air. In starting the motor, proceed as follows: See that the gasoline feed regulator lever is in the center position. Then make sure that the air control lever is in the center position, where it registers with the word *Hot* in the center of the plate. Note that the gasoline regulator lever should be moved over to the *Rich* position to facilitate starting in cold weather. When this is necessary, the air control lever should be moved over to the *Choke* position for a moment when cranking, and should be moved back to a position midway between choke and hot as soon as the motor starts. Have the throttle lever about an inch from the bottom of the quadrant and the spark lever midway or about three inches from the top of the quadrant. Pull out the ignition button on the combination switch as far as it will come. Have the left foot ready to use on the accelerator when the motor starts, and press down gently on the starting pedal with the right foot. If the starting gears do not mesh easily, do not force the starting pedal, but try to engage it again by returning the pedal to its normal position and again pushing it down slowly. Turn the air control to the *Cold* position when the motor warms up and is working smoothly. The change speed lever works in a slotted gate member and is in neutral position when it occupies the small passage between the two slots. The first speed is obtained by moving the lever to the left and pulling it back. The reverse motion is secured by moving the lever to the left and pushing it forward. The intermediate speed is obtained by moving the lever to the right and pushing it forward, while moving the lever as far back as it will go in the right-hand slot engages the high speed.

Hollier Eight.—In this control system, shown at Fig. 47, but one engine control lever is placed above the steering wheel. This is used to regulate the minimum speed of the motor and acts on the carburetor throttle. No spark advance lever is located on the steering wheel as the spark advance is controlled automatically by the ignition system. To make starting easy, however,

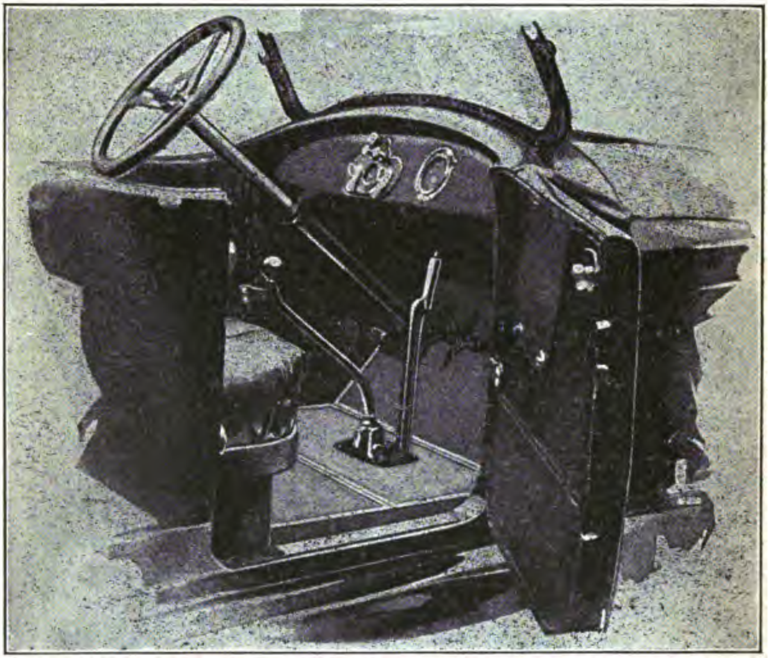


Fig. 47.—Driver's Compartment Hollier Eight Cylinder Car.

there is a spark retard button and a carburetor choke button carried above the ampere meter in the switch group. One switch controls the head and tail light, the other the current for the ignition system. The arrangement of clutch and brake pedal, emergency brake and speed changing levers conforms to conventional practice. The starting button is placed convenient to the driver's heel.

King Eight.—The illustration, Fig. 48, shows clearly the grouping of the various parts of the King Eight control system. The spark and throttle levers are in the retard position when at the lower end of the sector. The spark is advanced and the throttle is opened by pushing the levers away from the operator. A special form of "auto lock" reversing switch is mounted in the lower left-hand corner of the instrument panel to control the ignition circuit. The Yale lock key not only operates the lock for the current, but at the same time acts as a switch plug, opening and closing the ignition circuit and also reversing the polarity of the current when turned. To close the ignition circuit, insert the key in the lock and turn either right or left to position marked *On*. Note that there are two *On* positions. These should be used alternately, as reversing the polarity of the current will keep the make-and-break contacts in the timer-distributor in better condition than if the switch key was turned always the same direction. The starting switch button is located directly in front of the gear shift lever. The usual carburetor choke button is provided to secure easy starting in cold weather. The movement of the ball end gear shift lever is shown in the inset on the illustration. Moving the lever to the left and pulling back gives the low speed. To the left and forward gives the reverse. The right forward position is for intermediate speeds, while the right rear position engages the direct drive or high speed.

Kissel-Kar.—The parts of the control system the driver of a Kissel-Kar Model 6-42 should be familiar with are illustrated at Fig. 49. To start the engine, the first operation is to set the spark and throttle levers on the steering column. When they are up, or as far forward as they can go, the spark is retarded and the carburetor throttle is in a closed position. In starting the engine by hand the spark must be fully retarded, though it can be advanced by pulling it back about one fifth of its travel, when the electric cranking motor is used to turn the engine. The throttle should also be pulled back to correspond with the spark lever position. To give a rich mixture for starting, pull up the carburetor dash control knob marked *DA* and

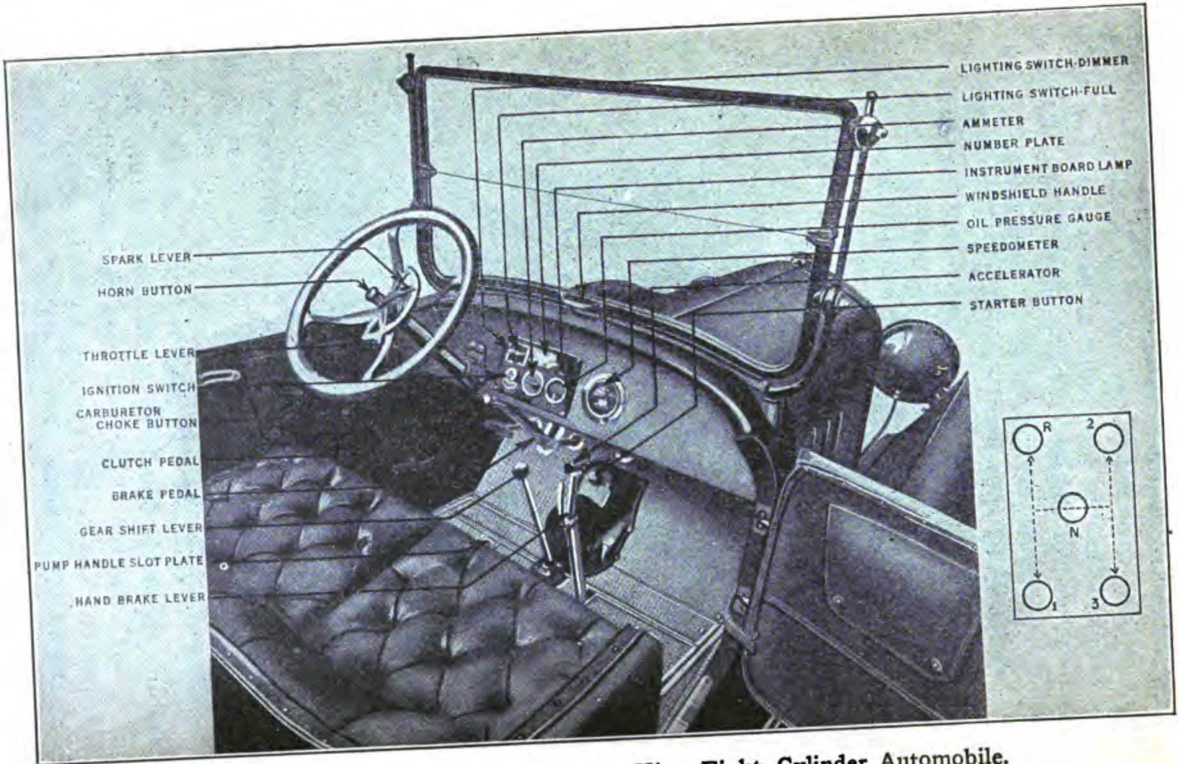


Fig. 48.—How the Driver Controls the King Eight Cylinder Automobile.

the choker knob as far as it would come. As soon as the engine starts the *Choke* knob must be pushed back and the dash control knob pushed down until the best running mixture is obtained. Turn the ignition switch to the *On* position. Push the starting pedal in the front floor board forward as far as it will go. As soon as the engine starts, release the foot pedal and the starter

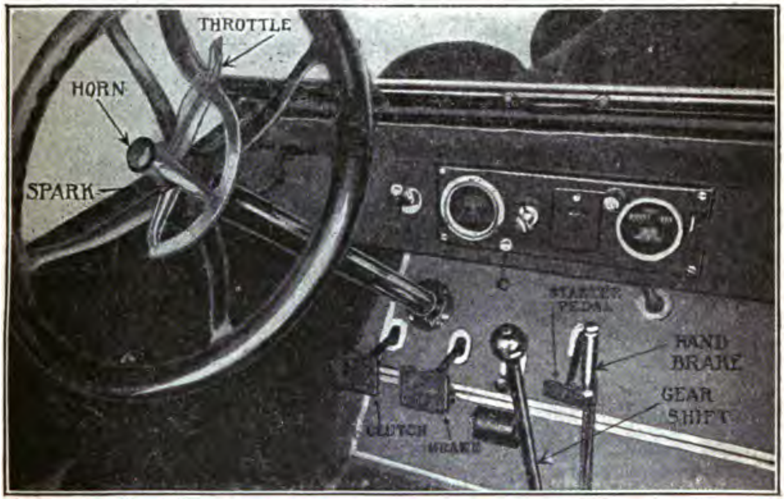


Fig. 49.—Control System of 1916 6-42 Kissel Kar.

gear will automatically disengage itself from the engine flywheel. Close the throttle lever so the engine runs slowly and advance the spark. The change speed lever is moved to the left and back to get first speed position, and to the left and forward for reverse. To the right and forward gives the intermediate speed, to the right and back gives the high speed.

Maxwell.—The control system of the Maxwell automobile is clearly shown at Fig. 50. The spark and throttle levers are placed below the steering wheel and at one side of the steering post. The retard position is at the top of the quadrant or away from the operator. The general instructions given for starting the motor of other cars can be followed in this one as well.

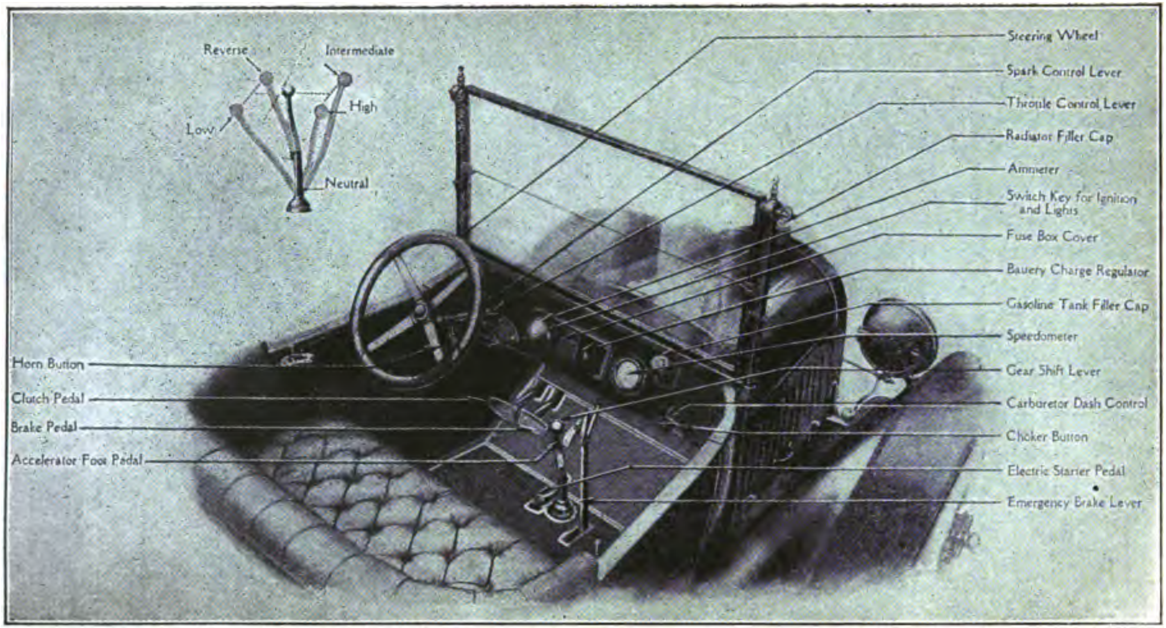


Fig. 50.—Control System of Maxwell Four Cylinder Automobile.

The positions of the gear shift lever for various speeds are clearly shown in inset.

Marmon.—The controls and instruments of the Marmon Model 34 will be grouped conveniently to the driver's seat as clearly shown in the illustrations at Fig. 51. When the switch box lever points to 0, all the electric circuits, including ignition and horn, are "dead"; when at 1, all are "live" lights; at 2, the small headlights and tail light are turned on; and at 3, the main headlights and tail light are lighted. A ground button is provided for shutting off the motor when it is still desired to use the lights or horn when the car is at a standstill. The knob marked *Choke* should normally be pushed all the way in, but should be pulled out to facilitate starting in cold weather. The right knob marked *In Lean—Out Rich* may be pulled out if necessary to enrich the mixture, but should be kept in as far as possible for smooth running. A muffler cutout lever and starter pedal are placed near the heel board, under the driver's seat.

The spark and throttle levers are placed above the steering wheel on top of the steering column. Each of these works on one half of the complete circle that serves as a guide member for the levers. The position of the throttle lever for starting is about one inch up from its lowest position and that of the spark lever is advanced to about two inches from the highest position. The ground button is turned as far as it will go, either right or left. The switch box lever should not be at the neutral or dead position. Gradually depress the starter pedal all the way down. If the starter only spins without turning the engine, immediately release pedal and wait until the starter stops spinning. Then push in the starter pedal more slowly. Be careful never to hold the starter pedal only part way down, as this may burn out the resistance in the starting switch. As soon as the engine begins to fire, release the starter pedal and push in the *Choke* knob. Lower the throttle lever so the engine will not race. To obtain the low speed position, the gear shift lever is moved to the left and pulled back. Moving it to the left and pushing it forward gives the reverse speed. Moving it to the right and forward engages the intermediate ratio. To

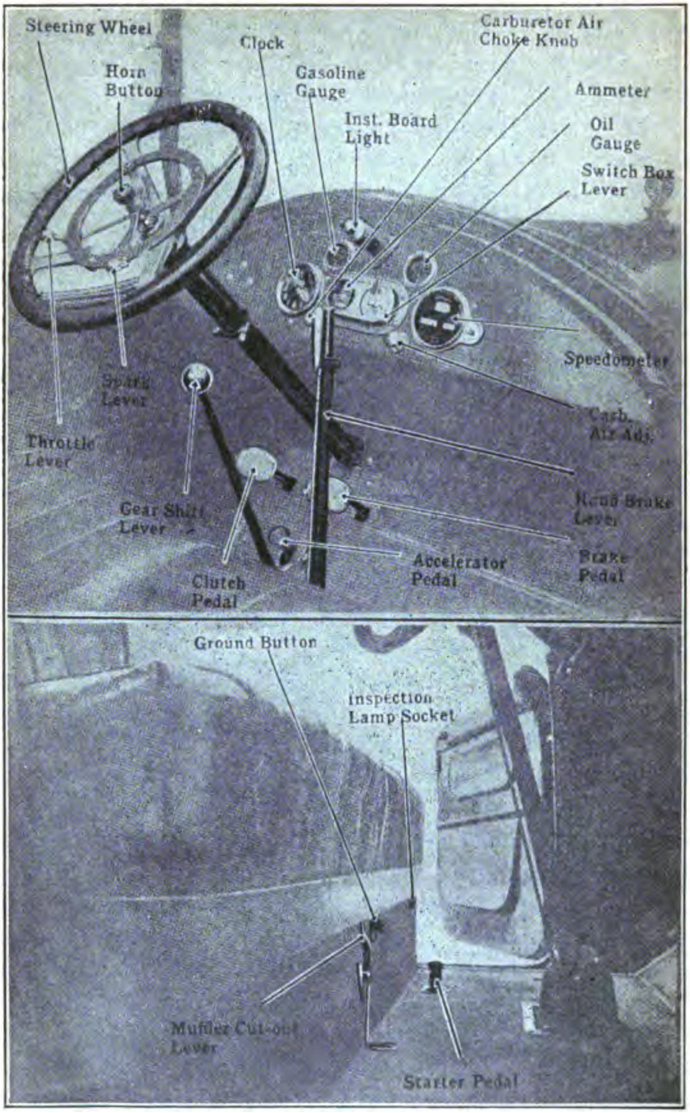


Fig. 51.—Arrangement of Control Levers and Dash Assembly on Latest Marmon Model.

engage the high speed the lever is pushed over to the right and pulled back as far as it will go.

Mitchell.—The control parts of the Mitchell Six of Sixteen should be readily understood from the detailed illustrations given at Fig. 52. The cowl board assembly is outlined in the upper left-hand corner. The floor board assembly, showing the

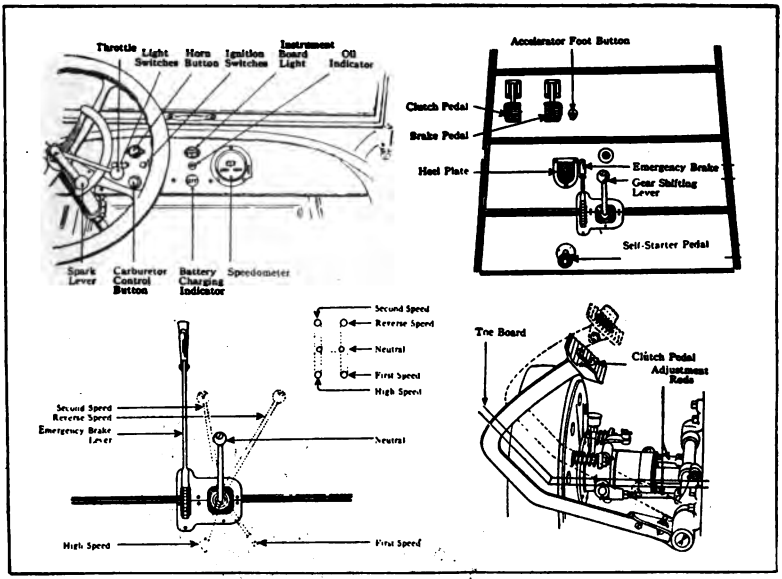


Fig. 52.—Control Element of Mitchell Six-of-Sixteen.

clutch and brake pedals, the accelerator and starting button and the brake and gear shifting levers, is shown in the upper right-hand corner. The positions of the gear shifting lever to obtain the various speed changes can be readily ascertained by inspection of the diagram in the lower left-hand corner. The spark is fully retarded and the throttle closed when the levers are on the low point of the quadrant. The instructions previously given for starting the motor of other cars applies to this one as well.

National.—The illustration at the left of Fig. 53 shows the appearance of the National driver's compartment when viewed

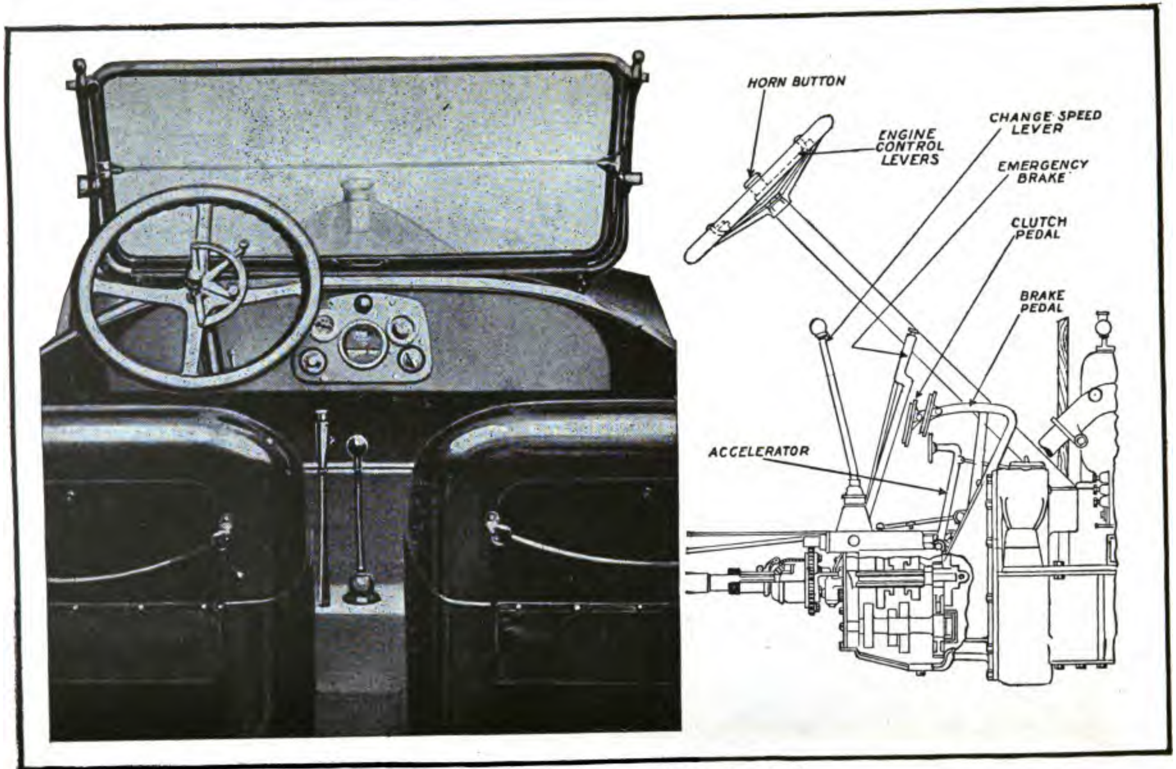


Fig. 53.—Control System of National Cars.

through the aisleway between the two front seats, while the relation of the various levers and pedals to each other is shown at the right of the cut. Of the two hand levers situated at the right of the driver, the right-hand one is used for changing speeds. This has a short extension lever which works in notches on the shifter rods, which are in turn connected to the shifting pinions in the transmission case. The change speed

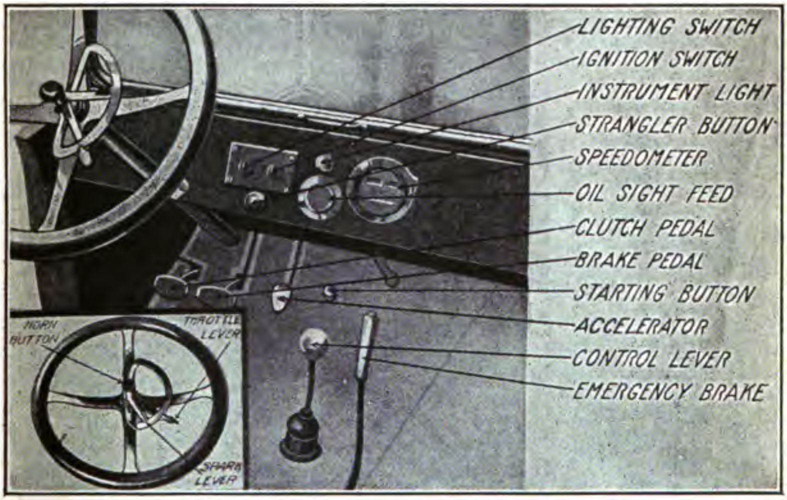


Fig. 54.—Driver's Compartment of Oakland Model 32.

control lever works by rocking it on a swivel support, the central position being the neutral one in which all the gears are out of mesh. The forward left-hand position gives the reverse gear, the rear left-hand position the first speed forward; the second speed forward is obtained by placing the lever in the forward right-hand position, and the high speed by placing the lever in the rear right-hand position. The other hand lever, which works on a ratchet, is used for operating the emergency hand brake. The left-hand pedal operates the clutch, the one at the right side the foot brake. The throttle pedal or accelerator is used for increasing the speed of the engine, while a plunger at the extreme right operates the electric starter. The

long lever on the steering post is used to regulate the spark timing, while the shorter one controls the carburetor throttle. This is a somewhat unusual arrangement. The spark is retarded when the lever is nearest the operator.

Oakland Model 32.—The various parts comprising the control system of the Oakland Model 32 are shown at Fig. 54. As all parts are clearly indicated it is not necessary to describe their use to any extent. An inset is presented in the corner of the illustration so that the spark and throttle levers may be identified, as well as their proper position for starting the engine. The ignition switch is combined with the lighting switch and is operated by turning an ignition switch key. Pressing on the starting button located in the floor board with the right foot throws the electric motor in action and spins the gasoline engine. As is usual with the starting system, if the motor does not start at once the "strangler" button on the cowl board is pulled out. This closes the air intake of the carburetor and gives a mixture that should fire easily as long as the air intake is closed. This action is the same as priming the motor and should produce the desired result even in the coldest weather. As soon as the motor starts, close the throttle lever to prevent racing and advance the spark by moving the spark lever about two thirds of the way up on the quadrant. Of course, the gear shift lever must be in neutral position before starting the engine, and the emergency brake applied. The emergency brake is actuated by pulling back on the lever. The gear shift lever is moved over toward the driver and pulled back to obtain the low speed. It is pushed forward on the left-hand side to engage the reverse gears. The intermediate speed is obtained when the lever is in the forward right-hand position and the high speed when the lever is in the left-hand rear position.

The instructions given for the Model 32 apply as well to the Model 50 Oakland, or eight-cylinder type. The general arrangement of the control members is the same as in the smaller car, except for the type of switch used and the addition of the carburetor needle button to the usual carburetor choker button. The gear shift lever positions, however, are different than they

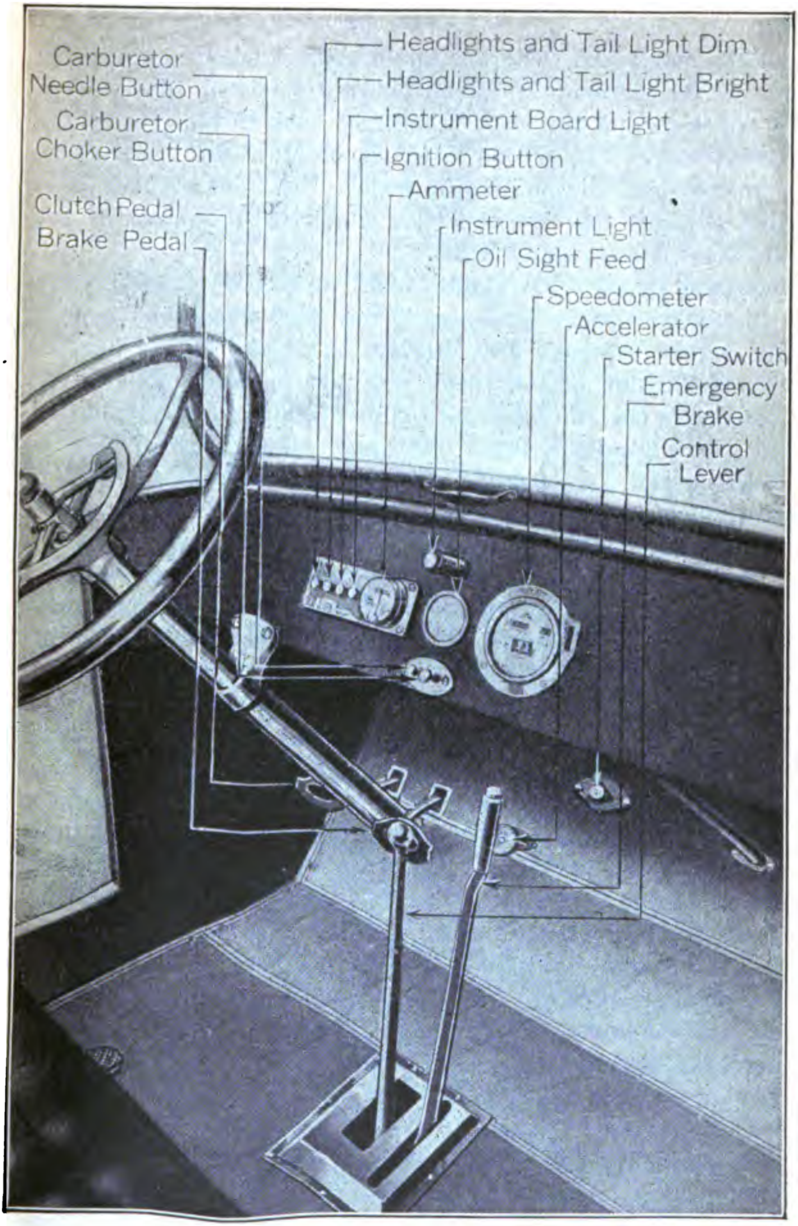


Fig. 55.—Control Group of Oakland Eight Cylinder Car.

are on the small car. The low speed gear is engaged when the lever is in the extreme right-hand forward position. The reverse gears are meshed if the lever is brought back to the rear of the right-hand slot. The second speed is obtained by rocking the lever to the left and pulling it back. The forward left-hand position engages the direct drive. The control system of the larger model is shown at Fig. 55.

Overland 75.—The Overland Model 75 is a very popular car that has been sold in large quantities and which has a very simple control system. The illustration at the top of Fig. 56 shows the location of the spark and throttle levers at the top of the steering post, and the ignition and lighting switch attached to the steering column below the hand wheel. An oil gage is mounted on the cowl board below the ampere meter, which is at the right of the speedometer. As the gasoline tank is carried in the cowl, the filler cap projects through the cowl board, as indicated. Below the filler cap is the carburetor priming button. The lower view, at Fig. 56, shows the control lever assembly, which does not differ materially from current practice. In starting the motor, the ignition switch, which is the second button down on the steering column switch box, is pulled out. The gear shifting lever is placed in its neutral position and the spark and throttle levers are placed in the proper position for starting. Both levers move away from the driver to speed up the engine. For starting the spark lever should be set about 2½ inches from the lowest position. The usual carburetor adjusting button should be pulled all the way out for starting in cold weather. It is left out till the motor warms up, after which it can be pushed down to its original position. All automobile makers caution against allowing the engine to race or run at excessive speeds without doing useful work. The racing tendency should be prevented by retarding the throttle lever until the motor turns slowly. The low speed position on this car is obtained by moving the lever to the left and pulling it back. If the lever is pushed forward the reverse gears are meshed. The forward position on the right-hand side gives the intermediate speed, while the rear placing of the lever on the right-hand side engages

the direct drive. It is important never to go into the reverse motion while the car is moving forward.

The control group and important parts of the larger Overland model are shown at Fig. 57. The control of these cars is just the same as that of the Model 75, except that instead of the "cane" shift the speed changing lever works in a gate slot

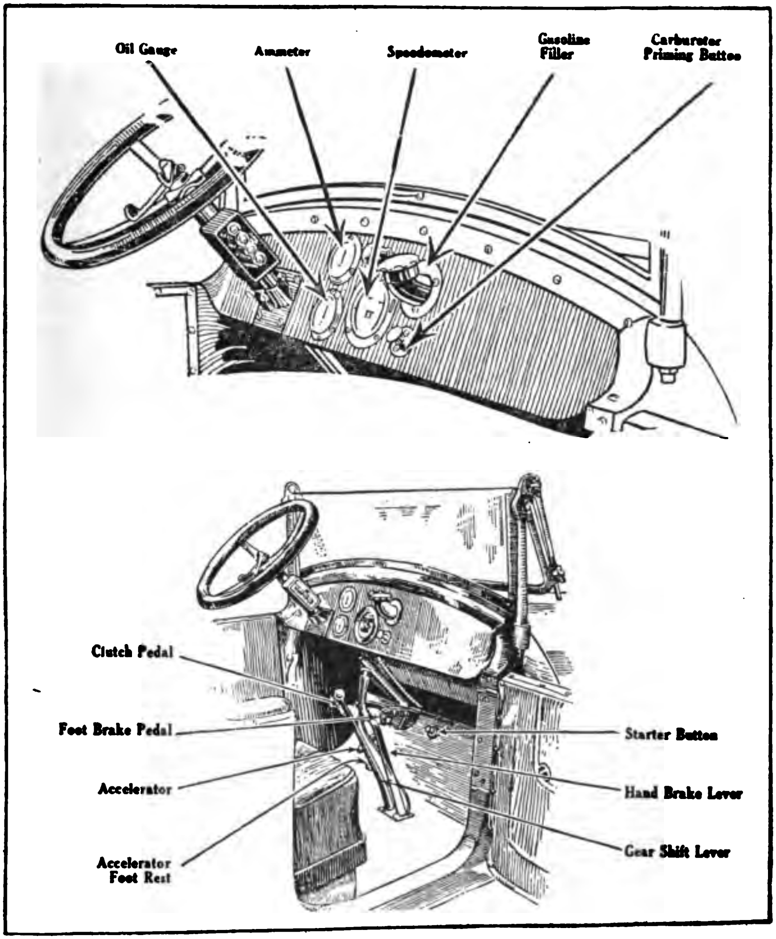


Fig. 56.—Overland Model 75 Control System and Dash Assembly. Note Lighting and Ignition Switch on Steering Column.

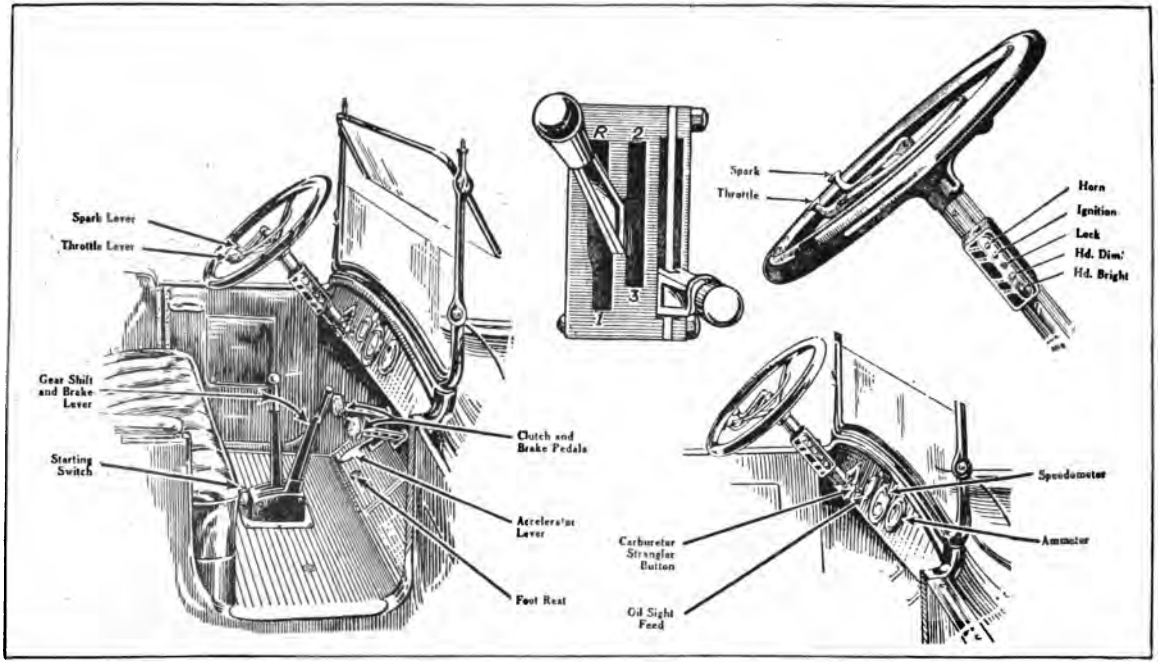


Fig. 57.—Arrangement of Control Levers on Overland Model 85 Cars.

or guide segment, though its positions for obtaining the different speeds are just the same. The placing of the spark and throttle lever and the location of the switch box on the side of the steering post are just the same as in the smaller model. The cowl board assembly is simplified by the elimination of the filler cap that projects through on the smaller model. The gasoline tank is carried at the rear on the larger Overland cars and a vacuum fuel feed system is used.

Packard Twin Six.—A very interesting and somewhat unusual sectional view of the Packard Twin Six car, shown at Fig. 58, outlines the various parts of the transmission and control system, as well as important parts of the mechanism and body. In this the change speed and emergency brake levers are mounted at the extreme left of the car, and not in the center, as is usual practice. Spark and gas control levers are mounted above the steering wheel on the steering column, and the control board and switch are attached to the column below the wheel and braced to the cowl board. As the fuel supply is by pressure feed, an air pump for pumping up pressure in the tank after the car has been standing for a time is also attached to the steering column. Preliminary to starting the motor the first step is to put the change speed lever in neutral position and to set the hand brake by pulling it back toward the driver. The hand throttle lever on the steering wheel which regulates the carburetor throttle is opened about one sixth. The auxiliary air valve hand wheel, which is a part of the control group, is turned toward *Gas,* indicated below it. In cold weather, or with a cold motor, turn the hand wheel all the way around to *Choke.* If the car has been standing for some time, use the hand pump to obtain initial pressure on the gasoline tank. Of course, as soon as the engine starts a power driven pump will maintain the required pressure automatically. Set the spark lever at mid-position. Crank the motor by pressing down on the starting button, convenient to the operator's heel. After the motor starts, turn the air valve wheel toward *Air* and set at the point at which the motor runs best. Close the throttle until the motor runs slowly. The left pedal actuates the clutch, that on the right the service brake.

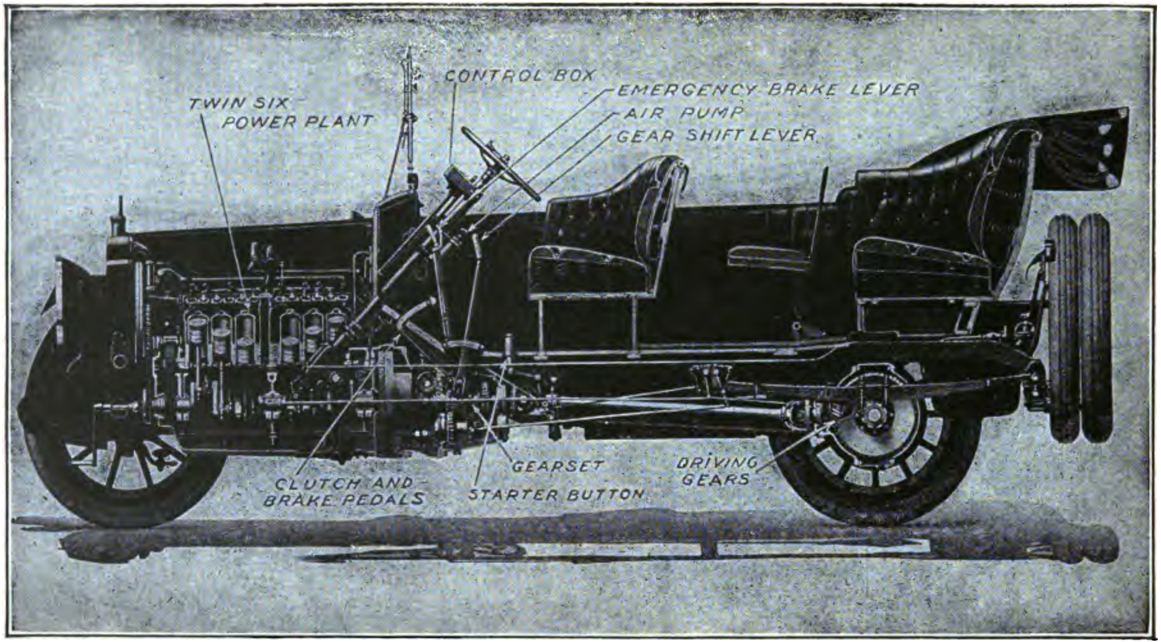


Fig. 58.—Sectional View of Packard Twin Six Chassis, Showing Power Generating, Speed Changing and Power Transmission Parts.

The spark lever should be advanced half way or more before attempting to start the car. To obtain low speed, the change speed lever is moved laterally inboard, or toward the right, then straight back. To obtain second speed, move the lever outboard, or to the left, and straight ahead. To obtain the third speed,

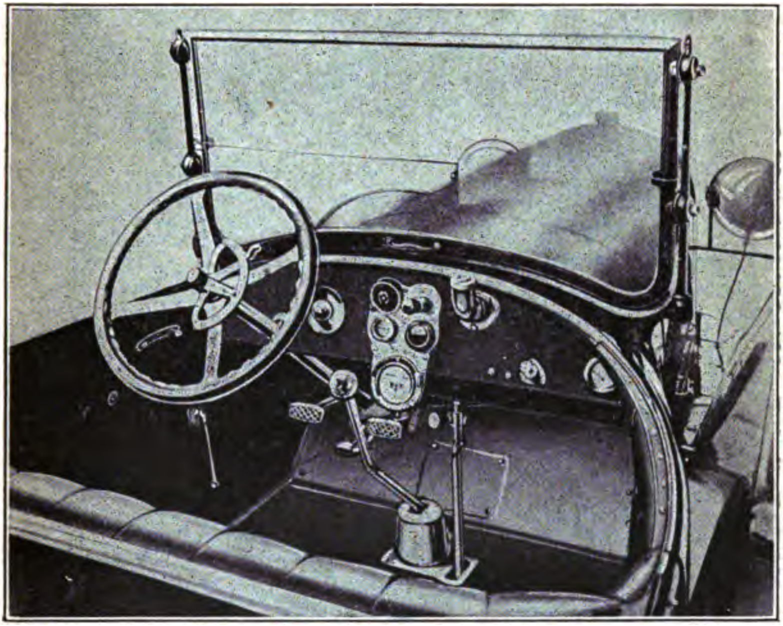
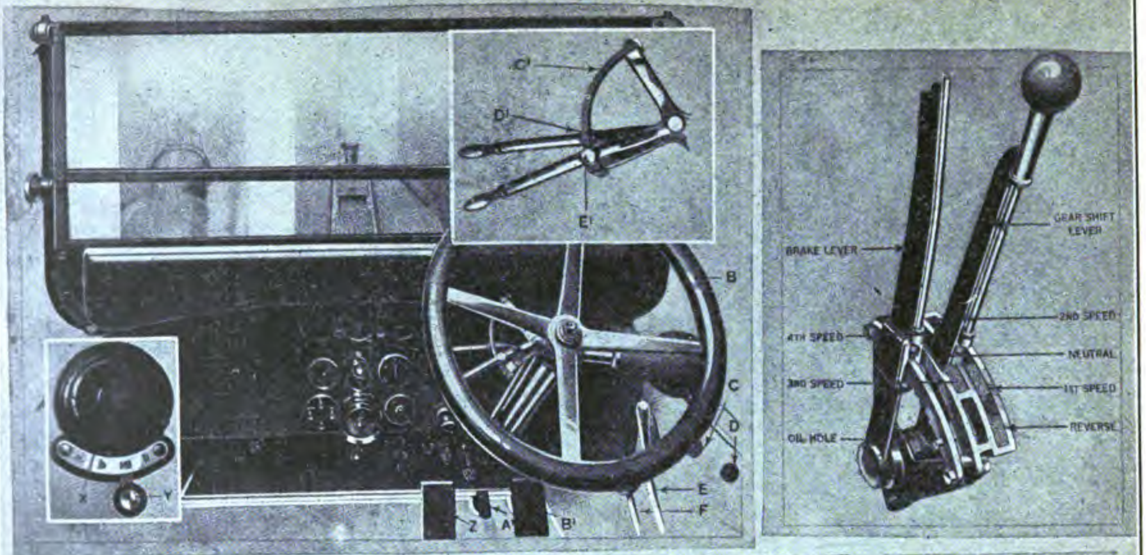


Fig. 59.—Control Group of Paige Cars.

pull the lever back in the outboard position. The reverse gearing is engaged in the forward inboard position.

Pierce Arrow.—The control system parts of the Pierce Arrow automobile are clearly shown in the illustrations at Fig. 60. Inasmuch as all of the parts are designated by letters, and a suitable key provided, it will not be necessary to explain the parts or their functions in detail. The instructions that have been previously given for setting the spark and throttle levers, putting the gear shift lever in neutral position and locking the emergency brake apply just as well to this car. If the car has



A—Gasoline Regulator on Column
B—Steering Wheel
C—Dimmer Button
D—Klaxon Horn Button
E—Hand Brake Lever
F—Gear Shifting Lever
G—Clock
H—Handle to operate Ventilator

I—Autometer
J—Knob for setting tenths of a mile
K—Speedometer
L—Knob for setting trip figure back to zero
M—Gasoline Gauge
N—Dash Lamp
O—Oil Gauge
P—Ammeter

Q—Spark Lever
R—Throttle Lever
S—Left-Hand Dash Cabinet Door
T—Lighting Switch
U—Starting Button
V—Hand Pressure Pump Handle (arrow pointing to the right—"off" position; arrow pointing to the left—"vent" position)

W—Primer Operating Button
X—Starting Switch
Y—Starting Switch Handle
Z—Clutch Pedal
A-1—Accelerator Pedal
B-1—Brake Pedal

Fig. 60.—Dash Assembly, Engine Speed Control and Gear Shift Lever of Pierce Arrow Cars.

been standing for a time it will be desirable to pump up pressure with the hand pressure pump handle *V*. For starting, the spark and throttle levers are placed as shown in the inset. The ignition switch is put into action by unlocking it with the special key provided for the purpose and then setting the starting switch handle *Y* on the switch position indicated by the letter *B*. There are four possible positions of the switch handle, the one marked *B* indicating "battery ignition"; the one marked *M*, at the other side of the switch, putting on the magneto ignition; the position *O* means that the switch is off, while the letters *M,B* show that both ignition systems are in use. Pressing on the starting button *U* should bring the electric starting motor into action and turn the engine over. The Pierce Arrow cars are provided with a four-speed sliding gear transmission, so that the control system is somewhat different than in the simpler three-speed shifts. The change speed lever is guided by an unusual form of H-slot segment having one long slot and a shorter one. To obtain the reverse speed, the gear shift lever is moved from its neutral position and to the extreme end of the longer slot, in the position indicated as reverse in the large detail view of the levers. It is necessary to pass through the first speed before the lever will go into reverse. There are three possible positions for the gear shift lever in the long slot. The extreme forward position gives reverse; that just ahead of the neutral notch gives first speed, and that at the back of the sector gives second speed. The third speed forward is obtained at the forward end of the short slot, and the high speed at the back end.

Reo.—The control system of the Reo cars is very simple and but one hand lever is used. As will be seen by reference to Fig. 61, the clutch pedal will release the clutch when moved about half way of its possible travel. Further movement applies the service brake. The brake pedal is provided with a latch so that it may be locked at any desired point and the car held from moving by virtue of the emergency brake. The usual spark and throttle levers are carried above the steering column. The lighting switch is at the left side of the steering post, immediately below the hand wheel, while the ignition switch is on the

ght side. The spark and throttle levers are moved forward to crease the engine speed. The proper position of the levers r hand starting is shown in the illustration. When using the ectric starter the spark lever may be advanced to a greater egree than shown. A conveniently placed starting button,

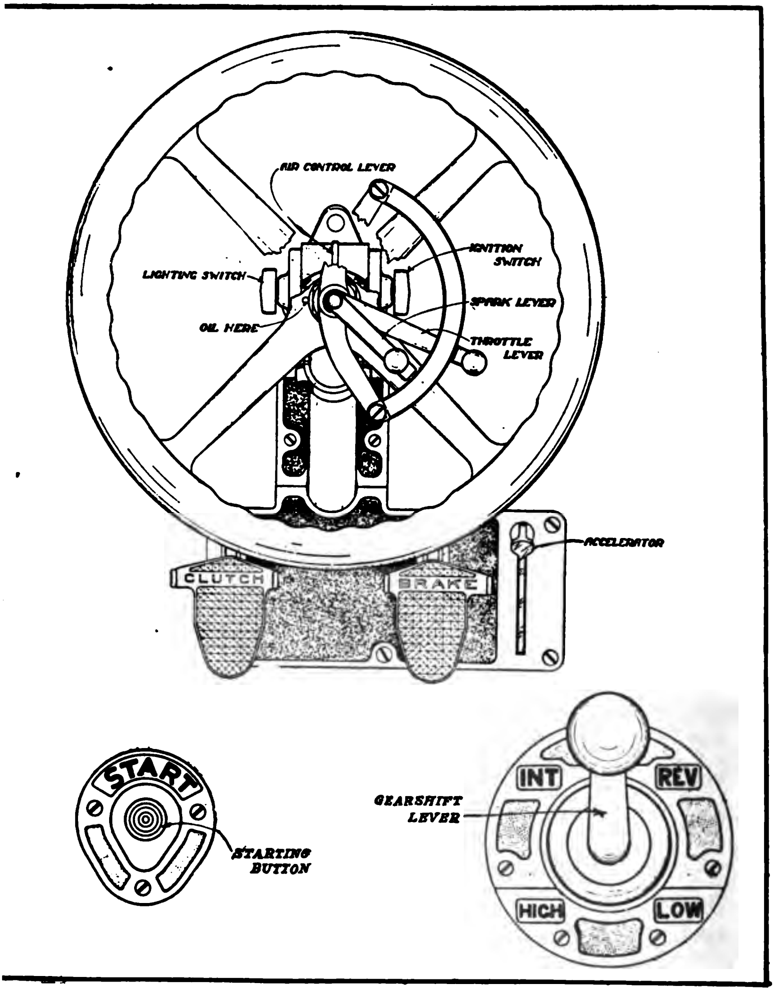


Fig. 61.—Control System of Reo Automobiles.

plainly marked, that can be operated by the driver's foot, puts the electric starting motor in action. The gear shift lever is also provided with a marked guide plate, so the various positions of the lever to obtain the different speed ratios are clearly indicated.

Stearns-Knight.—The driver's compartment of the Stearns-Knight cars is clearly illustrated at Fig. 62. The spark and

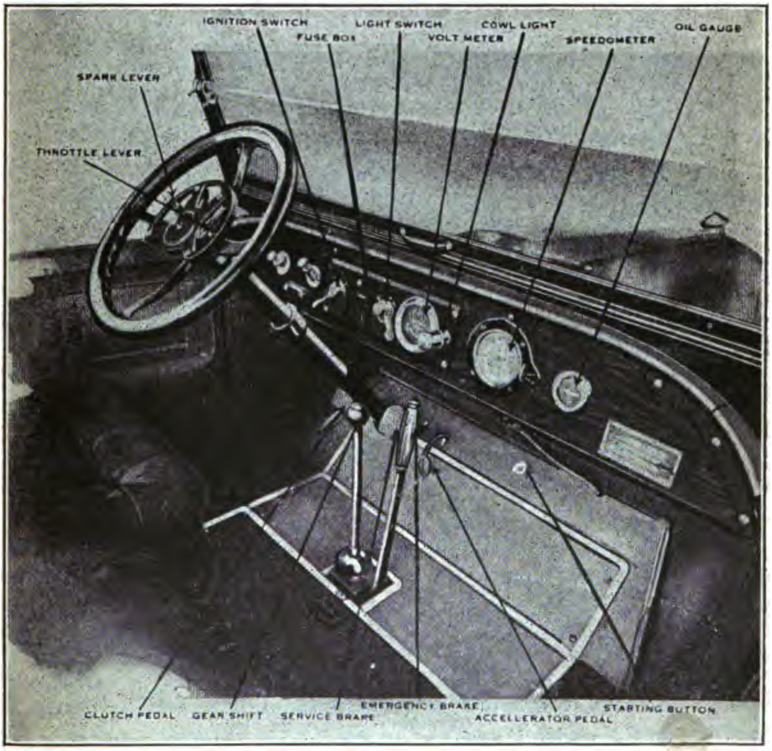


Fig. 62.—Stearns Knight Control Group.

throttle levers are carried above the steering column in the usual manner, but are so arranged that the spark lever works on the left side of the fixed quadrant, while the throttle lever works on the right side. The usual accelerator pedal is provided

for altering the engine speed. Before starting the motor it is necessary to see that all control levers are in their proper positions. If this is done there can never be any accident when starting. The first step is to advance the spark lever by moving it up about half way on the quadrant. The throttle lever is moved up about one and one half inches from the bottom. Pull the carburetor "choker" all the way out. Turn on the ignition

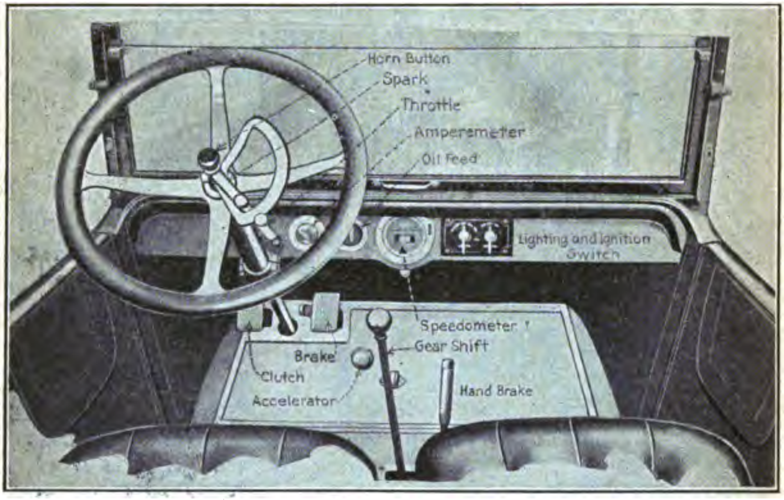


Fig. 63.—Studebaker Assembly and Control Levers.

switch and press down the starting button, which is located centrally in the top of the toe boards. Note that the ignition switch is carried at the left of the switch panel and that the lighting switch is carried at right. A receptacle for spare fuses and for the fuses of the electrical system is placed between the ignition and lighting switch levers.

As soon as the engine starts, watch the oil gage to make sure that the oil is circulated. The gage should never indicate less than three pounds pressure when the engine is idling. In cold weather it may be necessary to admit raw gasoline to the cylinders to insure the engine starting. This may be done by filling the priming cups on top of the inlet manifold with gasoline or

ether and letting this amount flow into the manifold interior. The petcock should be closed before starting the motor.

Attention is directed to an oil regulator, which is similar to the carburetor primer, located on the extreme left-hand side of the instrument board. This regulator controls the pressure of the oil and should be used wherever the anti-smoking ordinances are not too stringent, as it is a better and more efficient means toward general lubrication of the motor, although it will cause the engine to smoke a little. In operation this oil regulator is similar to that of the carburetor primer. To increase the oil pressure pull the choke up as far as it will go. Then observe the oil gage and the exhaust. If the smoke is too heavy, push the plunger part way down, again observing the oil gage and exhaust and thus marking the amount of pressure and the position of the regulator at the point where the lubrication is most efficient and smoke the least. When running the engine at high speeds, keep the regulator all the way out. The reason that lubrication should be watched carefully is because the Stearns-Knight engine employs sliding sleeve valves instead of the usual poppet valves. In order to secure smooth engine action it is very important that constant lubrication be obtained.

The slow speed position of the gear shifting lever is to rock it to the left and pull it back toward the driver's seat. The reverse, following the conventional "cane" shift practice, is on the same side as the low speed and in the forward position. When the lever is rocked to the right side, the second speed lines up with the reverse and is the forward position, while the high speed lines up with the low speed and is that position nearest to the driver's seat. The reason the low and the high are usually at the same end of the imaginary H sector is because it is often possible to go from the low speed directly to the high speed without passing through the intermediate. This can be done on the level or when descending a slight incline. On slight upgrades it is necessary to go into the intermediate speed before the direct drive is engaged.

Scripps-Booth.—The driver's compartment of this popular car is illustrated at the top of Fig. 64, while the positions of the

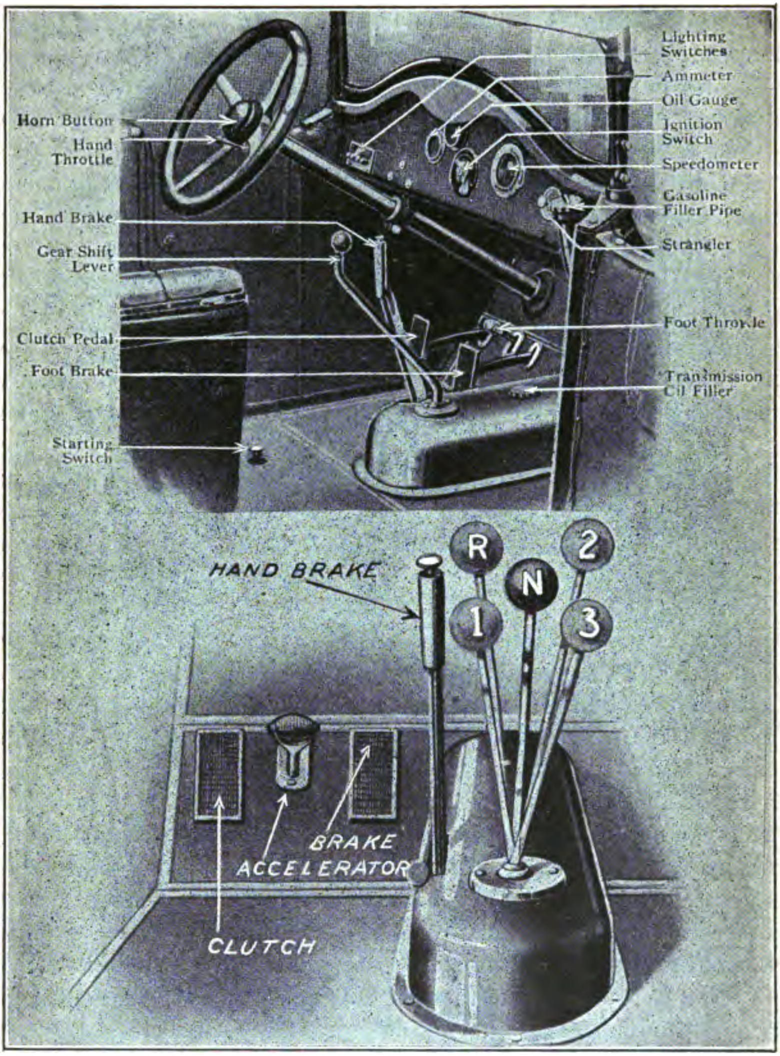


Fig. 64.—Control System Parts and Gear Shifting Diagram of Scripps Booth Automobile.

gear shift lever necessary to obtain the various speed ratios are clearly shown at the bottom of the cut. No spark advance lever

is provided on this car because an automatic spark advance is incorporated in the ignition timer-distributor. In starting this car, evidently there is only one engine control lever to set. The hand throttle does not describe a horizontal arc as in the other systems outlined, but instead is moved over a vertical arc when it opens the throttle. The usual strangler plunger or carburetor

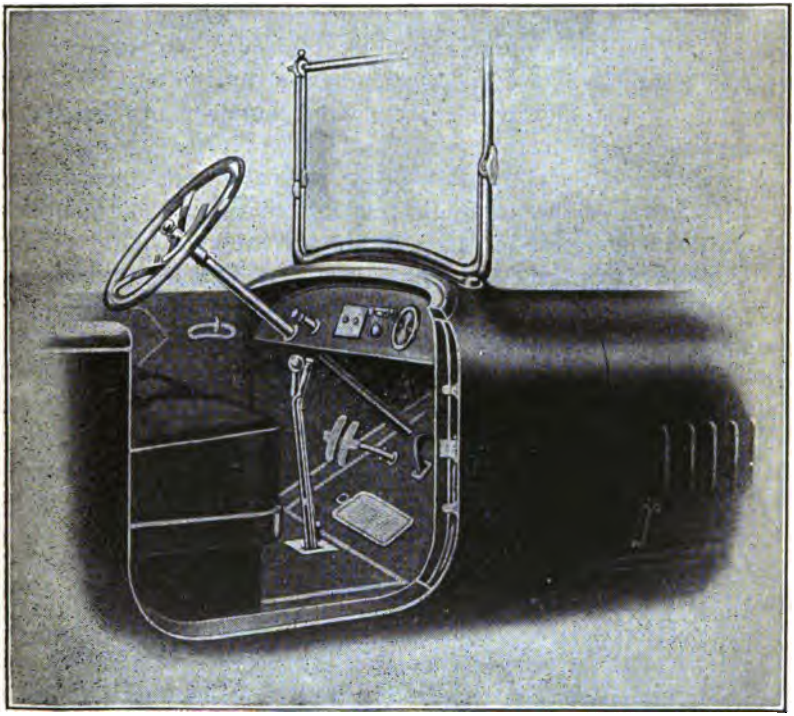


Fig. 65.—Velie Control System.

choke is provided on the cowl board to facilitate starting in cold weather. The ignition switch is placed in the approximate center of the cowl between the speedometer and the oil gage. The steps for starting this car are just the same as recommended for any electrically started machine. The starting switch is operated by a push button that can be easily actuated by the driver's heel.

Velie.—The control parts of the Velie Model 22 are shown at Fig. 65. The clutch and brake pedals are capable of being adjusted to meet the needs of any driver. An electric horn button is located in the center of the steering wheel, as is quite general practice; and but one hand control lever, the throttle, is necessary, as the usual spark control lever is not required because the time of ignition is controlled by a governor and automatically advances or retards as the speed of the motor varies. When the motor is at rest, the spark will always be retarded. As the motor speed is increased by the hand throttle lever, or by the foot accelerator which supplements it, spark timing is advanced to that point best suited for the engine speed. The cowl board is inclined in order that the instruments may be easily read by the driver. From left to right, their order is as follows: carburetor air adjustment and air cutoff, and double switch controlling any combination of lights, ignition and reversing polarity. A single key fits both switches. The indispensable ampere meter and a magnetic speedometer complete the assembly. The starting motor is operated by a simple push button located on the lower dash, where it can be conveniently reached with the foot. The conventional "cane" shift is employed for engaging the various speed ratios.

CHAPTER IV

CARE OF AUTOMOBILES

Winter Care of Automobiles—Anti-Freezing Solutions—Maintenance of Body Finish, Tops and Upholstery—Care of Storage Battery—Tools and Repair Equipment—General Supplies—Motor Troubles—Road Repair of Tires—Extricating a Mired Automobile.

Winter Care of Automobiles.—While motoring throughout the entire year is not unusual, many owners of cars, especially in those portions of the country where the winter climate is exceptionally severe, put up their car for a period. If the car is to be kept in service, the most important thing to do is to provide some good anti-freezing compound in order to prevent the water in the radiator and cylinders from congealing. There is some difference of opinion regarding the best solution to use to prevent cracked water jackets and burst radiators. Before we attempt to answer the questions often asked regarding the best anti-freezing compound, it will be well to consider the requirements of such compounds. To begin with, it should have no deleterious effects on the metals or rubber used in the circulating system. It must be easily dissolved or combined with water, should be reasonably cheap and not subject to waste by evaporation, and be of such character that it will not deposit foreign matter in the pipes. The boiling point should be higher than that of water to prevent boiling away of the solution at comparatively low temperature.

Solutions of calcium chloride were formerly very popular with motorists, and the writer will first discuss the use of this substance. The freezing point of the solution depends upon the proportions of the salt to the water. An important factor to be considered is that if the parts of the circulation system are composed of different metals there is liable to be a certain electro-

lytic action between the salt and the dissimilar metals at the points of juncture, a certain corrosion taking place, and the intensity of this corrosive effect is only dependent upon the strength of the solution. As calcium chloride is derived from hydrochloric acid, which has a very strong effect on metals, and as there may be particles of free acid in the solution, a certain undesirable corrosive action may take place unless the salt is reasonably pure.

In using calcium chloride when compounding an anti-freezing solution, care must be taken that commercially pure salt is employed, as the cruder grades will liberate a larger percentage of free acid. The mistake should not be made of using chloride of lime, which has much the same appearance, but whose corrosive action is very great. Galvanized iron tanks and cast aluminum water manifolds and pump casings prohibit the use of this salt, as its destructive action is great on these metals.

It is well to test a solution of calcium chloride for acid before placing in the radiator. A piece of blue litmus paper may be obtained at any drug store and immersed in the solution. If the paper turns red it is a sign that there is acid present. Acid may be neutralized by the addition of a small quantity of slaked lime. The solutions may be made in these proportions:

Two pounds of salt to the gallon of water will freeze at 18° Fahr.

Three pounds of salt to the gallon of water will freeze at 1 5/10° Fahr.

Four pounds of salt to the gallon will freeze at 17° Fahr. below zero.

Five pounds of salt to the gallon will freeze at 39° Fahr. below zero.

It must be remembered that the more salt to the solution, the greater the electrolytic effect, and the greater the liability of the deposit of salt crystals, which may obstruct the free flow of the liquid.

Glycerin is usually considered quite favorably, but it has disadvantages. It often contains free acid, though the action on metals will be imperceptible in average solutions. While it

does not attack metal piping to any extent, it is sure destruction to rubber hose, and should not be used in a car in which part of the circulation system piping is of rubber. Glycerin is expensive and it is liable to decompose under the influence of heat, and proportions added to the water must be higher than that of some other substances.

Denatured alcohol is without doubt the best substance to use, as it does not have any destructive action on the metals or rubber hose, will not form deposits of foreign matter and has no electrolytic effect. A solution of 60 per cent water and 40 per cent alcohol will stand 25° below zero without freezing. The chief disadvantage to its use is that it evaporates easily and its boiling point is quite low. Alcohol volatilizes more rapidly than water and the solution is liable to become too light, as proportions of alcohol to water are concerned. The percentage required is shown in the following:

Water, 95 per cent; alcohol, 5 per cent; freeze at 25° Fahr. Water, 85 per cent; alcohol, 15 per cent; freeze at 11° Fahr. Water, 80 per cent; alcohol, 20 per cent; freeze at 5° Fahr. Water, 70 per cent; alcohol, 30 per cent; freeze at 9° Fahr. below zero. Water, 65 per cent; alcohol, 35 per cent; freeze at 16° Fahr. below zero.

Various mixtures have been tried of alcohol, glycerin and water and good results obtained. The addition of glycerin to a water-alcohol solution reduces liability of evaporation to a large extent, and when glycerin is used in such proportions it is not liable to damage the rubber hose. The proportions recommended are a solution of half glycerin, half alcohol, to water. The glycerin in such a solution will remain practically the same, not being subject to evaporation, and water and alcohol must be supplied if the amount of solution in radiator is not enough. The freezing temperatures of such solutions of varying proportions are as follows: Water, 85 per cent; alcohol and glycerin, 15 per cent; freeze at 20° Fahr. Water, 75 per cent; alcohol and glycerin, 25 per cent; freeze at 8° Fahr. Water, 70 per cent; alcohol and glycerin, 30 per cent; freeze at 5° Fahr. below zero. Water, 60 per cent; alcohol and glycerin, 40 per cent; freeze at

23° Fahr. below zero. The proper proportions to be used must be governed, of course, by conditions of locality, but it is better to be safe than sorry, and make the solutions strong enough for the extreme that may be expected.

Oils of various kinds are often used exclusively, as it is obvious that oil and water would not form a very good mixture. They are of the character that is often used to lubricate ice-making machinery, and are made especially to withstand low temperatures. The oil will not absorb heat as readily as water, and should only be used where exceptionally good methods of cooling are provided, such as a large radiator, all metal piping and a very positive pump. This oil will attack rubber hose and gaskets, however. It would seem to the writer, from actual experience, that wood alcohol solutions were preferable to others as combining the greatest number of the requirements of a practical anti-freezing compound and being more easily handled.

After due care has been taken with the cooling system to prevent freezing, the next point to observe is the lubrication of the motor. This will depend on the oil system used and the grades of oil which are normally employed. As a general rule, it is well to use a lighter grade in the winter than that utilized during the warmer weather. If the clutch is a multiple-disk member, it should be filled with light oil of as high cold test as it is possible to obtain. If sight-feed glasses and exposed tubing form part of the lubricating system, or the oil tank or mechanical lubricator is carried in an exposed position, it should be remembered that this part should be inspected frequently to make sure that the oiling system is functioning properly.

During cold weather a certain amount of difficulty is always experienced in starting the car, especially when one considers the low grade of gasoline used at the present time. If the motor is provided with compression relief or priming cocks, a small hand oil can should be filled with gasoline and ether mixture, of proportions about half and half, and kept tightly corked to prevent evaporation of the volatile liquids. On a cold morning, when the motor is hard to start, this liquid may be injected into the cylinders through the priming cock, or by removing the spark

plugs if relief cocks are not provided, and the motor will be started without difficulty. During extremely cold weather, if the car is kept in an unheated garage, it is good practice to fill the cooling system with boiling hot water before trying to start. The anti-freezing solution may be saved after it is drawn from the radiator to allow the boiling water to be put in, and after the engine has become heated the water may be drawn out and the cooling solution replaced. Always let the engine run for five minutes before trying to run the car in cold weather. Never start off with the engine cold. Watch the storage battery carefully and make sure it is kept properly charged.

Maintenance of Body and Upholstery.—Many motorists are at loss to understand the reason for quick deterioration of the brightly varnished surfaces of a motor car body that has been in use for some time. The paint may be blistered or cracked or the finish may be spotted at various points. Bodies that were formerly black will assume a bluish tinge and bright varnish will soon become dull. If the car is an expensive one, the motorist is justified in expecting a degree of finish that will endure; but those who purchase cheaper cars may expect to lose the bright finish after the car has been used for a time. Where cars are manufactured in large quantities, the varnish is often applied before some of the under coats are thoroughly dried, and the result will be a series of blisters. Another result of hasty manufacture and of putting the car in service soon after painting is spotting. This is produced by dry mud, which extracts some of the oil or gum from the varnish, and may often be caused by actual chemical action of alkaline mud. The mud of city streets, especially at points where there is a great deal of animal traffic, is highly charged with ammonia, and in certain clay or lime districts the mud is very destructive to the varnish luster.

Even when a car has been properly varnished and finished there are many conditions, for which the motorist is directly or indirectly to blame, which will ruin even the highest grade of paint and varnish. For instance, when cars are cleaned at garages, various soaps and washing compounds are used which contain alkaline materials to assist in removing dirt and oil but

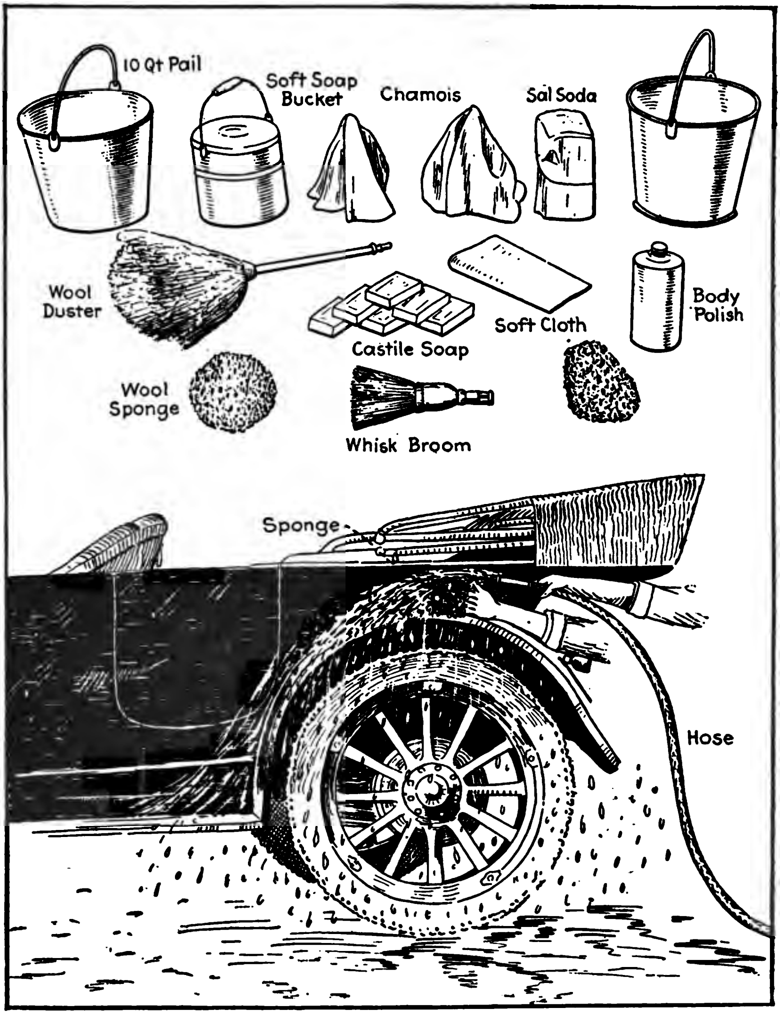


Fig. 66.—At Top, Supplies Needed for Washing and Cleaning Cars are Shown. Method of Washing With Sponge and Hose Illustrated Below It.

which are very destructive to the highly finished, varnished surfaces. Most of the soaps upon the market contain ingredients which have a chemical action on the oils of paint and cause

it to deteriorate. There are soaps which do not damage painted surfaces, but these are usually more costly and require more care and labor to remove the dirt accumulation, so they are not apt to be generally used. The grades of soap that act the quickest in cutting grease are those that will more quickly dull the surfaces of the body.

Some very expert carriage painters go so far as advising that no soap be used on finely varnished surfaces. Some painters advise against dusting off a car and claim that accumulations of this substance should be removed from the surface by washing. It is contended that wiping off the dust will have the effect of scratching the varnished surfaces, and that the best method of removing either dust, dirt or mud is to flush the surfaces with water from a hose. After as much of the dirt has been removed by this method as possible, a sponge may be used, but care must be taken that no grit is permitted to collect beneath the sponge and that the stream of water from the hose be always kept at work ahead of the sponge, as shown at Fig. 66.

If any grease is present on the running gear it should be removed with gasoline or benzine, and, while these substances may deaden the varnished surfaces temporarily, the blemish will not remain if the dull varnish is polished with a clean, soft cloth wet with linseed oil. The finish of many automobiles is ruined by allowing accumulations of oil or asphalt from freshly tarred or oiled roads to remain on the body work. These substances should not be allowed to remain any longer than possible, and if the oil or asphalt has become hardened, it may be dissolved by using naphtha, kerosene, vaseline, or even butter. After the oily accumulations have been dissolved, the car should be very carefully washed to remove all traces of the oily mud or the solvents.

Of course, there are portions of the car where it is difficult to have the paint stay in good condition. The paint is often burned off that part of the hood on a gasoline machine adjacent the exhaust pipe, or on those portions of the hood of a steam car which cover the boiler or burner. Any part of the hood subjected to considerable heat will become discolored after a time, and if

the heat is intense the paint will burn and blister. If care is taken to keep the body properly washed by using only the best grade of carriage soap obtainable, and only clean water, sponges and chamois cloths, the body finish will be preserved for a much longer time than if washing is neglected and the mud or dirt allowed to dry on the varnished surfaces. The use of quick-acting soaps should be avoided as much as possible, and tar or oil accumulations should be removed as soon as conditions will permit. If a car is kept in a barn or shed housing horses or cattle, or adjacent to a stable, the fumes of ammonia will soon cause a deterioration of the paint and varnish. One should never touch dusty surfaces with the hands or attempt to remove the dust by brushing off with a cloth. As a general rule, an automobile body will need to be gone over every season. The first year that the car is in use the paint should be in good enough condition, if proper attention has been paid to washing, so that a coat of varnish will suffice to restore the body to its pristine brilliancy. A car that has been used more than one season will need both painting and varnishing to make a good job.

The matter of cleaning and caring for tops and upholstery is also one that should be considered to some extent. Mohair or leather tops are usually fitted to high-grade cars; mohair or special fabric materials to medium-priced cars, and imitation leather or mohair substitute on the cheaper cars. In cleaning mohair tops, it is necessary to remove not only dust and dirt, but particles of grease or oily matter thrown up against it by the wheels from either the road surface or portions of the mechanism. Dust should be removed with a moist sponge, while grease or oil stains can be taken off by a sponge and good soapsuds. Leather and imitation leather tops should be treated with some form of preservative. Some dressings may be purchased all ready mixed and may be applied by the motorist himself. Others may be prepared at very little expense. Shabby leather may be made to look brighter by rubbing over the surface with either linseed oil or the well-beaten white of an egg mixed with a little black ink. Before applying any type of dressing, it is advised to go over the surface with neatsfoot oil until it has

been properly softened, and often the oil treatment will be sufficient for all practical purposes.

The following recipe is given as a good preservative for leather. It is composed of six parts of spermaceti, eighteen parts of beeswax, five parts of asphalt varnish, five parts black vine twig, two parts Prussian blue, one part nitrobenzol, one part powdered borax and sixty-six parts of oil of turpentine. The wax is melted and the borax is added, after which the mixture is stirred until a jellylike mass is formed. In another pan the spermaceti is melted, the varnish (which has been previously mixed with the turpentine) is added, and the mass stirred well and added to wax mixture in the other vessel. The color is the last ingredient added, this having been previously rubbed smooth with a little of the mixture. The material is applied with a brush about once a week, in small quantities, and is wiped well with a soft cloth to polish after application.

Another formula for giving new life to leather tops or upholstery is given as follows:

Ground Ruby Shellac................	2.25	parts
Dark Resin..........................	.91	parts
Sandarac	.115	parts
Gum Resin..........................	.115	parts
Aniline Black (Spirit Soluble).......	.115	parts
Lamp Black.........................	.115	parts
Wood Alcohol.......................	22.50	parts

The first step in preparing this mixture is to dissolve the sandarac, dark resin, gum resin and shellac in the alcohol; next the aniline black is added, and finally the lamp black, which has been ground to a paste with a little of the liquid, is mixed in. After the whole has been thoroughly mixed it is filtered. This is applied to the top or upholstery with a brush and is polished with a soft cloth.

On genuine leather tops, upholstery, and for the leather straps holding the top, applications of a good grade of harness oil are often sufficient. The following will be found an effective mixture:

Oil of Turpentine	2	ozs.
Lamp Black	½	oz.
Neatsfoot Oil	10	ozs.
Vaseline	4	ozs.

The lamp black is mixed with the turpentine and the neatsfoot oil, and the vaseline is thinned by heating it, and the ingredients are mixed by shaking together. When the mixture cools it will be in the form of a grease or paste, which is rubbed well into the leather to be preserved or softened.

If a car has been used on a wet or stormy day, the top should be kept up until it is thoroughly dry, as if it is inserted in the top case or folded while wet the lining might mildew or rot. In folding tops care should be taken to have the folds even and to have as few wrinkles as possible. The various bows comprising the framework of the top should be separated by small rubber pads and the whole firmly strapped together by leather bands applied at each side of the folded top frame to prevent rattle.

Upholstery is usually preserved by slip covers of various grades of cloth applied to the cushions and to the backs of the seats. As most cushions and seat backs are upholstered with leather, or the various fabrics imitating it, the same dressings that have been recommended for tops may be used to advantage in treating the cushions and seat backs. In some of the higher-priced cars, especially of the closed body form, various grades of broadcloth, Bedford cord, or other textile fabrics are used. When these become dirty they must be treated very carefully and by an experienced cleaner, because ordinary methods of removing grease spots will cause unsightly discolorations of the fine fabrics. Where high-grade upholstery materials are used, slip covers are really necessary. These should be kept in place at all times that the passengers are in ordinary street or business dress, but may be removed and the clean upholstery used at such times that it is desirable not to dirty the clothing, as when evening clothes are worn.

Care of Storage Battery.—The storage battery is made up of

several hard rubber cells or containers for the active plates and liquid electrolyte. The whole is surrounded by a wood casing for mechanical protection and ease in handling. Each individual cell is provided with a screw cap for inspection and the addition of electrolyte or distilled water when necessary. The electrolyte must at all times cover the tops of the plates at least one quarter inch. Insufficient electrolyte will result in warped or buckled plates, and an accumulation of sediment at the bottom of the cells. The battery will be ruined in a short time if the tops of the plates are not kept covered. Each cell must be inspected at least once every week in summer and once every two weeks in winter. All screw caps must be removed and distilled water added to each cell to make up for the natural evaporation. If distilled water cannot be had, use clean rain water which has not come in contact with metal or cement.

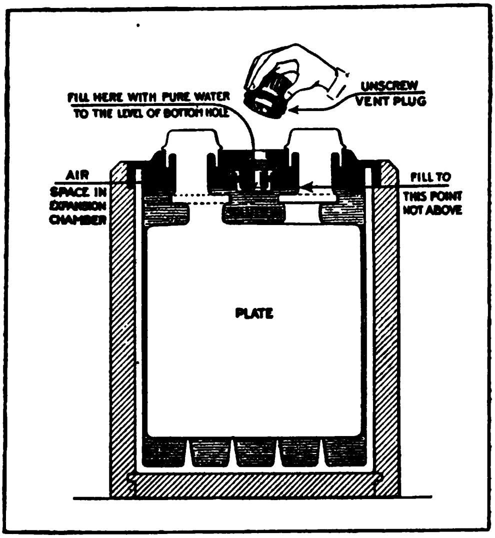


Fig. 67.—Sectional View of Storage Battery Showing Proper Height of Electrolyte in the Cells.

Never add acid to the cells of the battery. If part or all of the electrolyte has been lost through accidental spilling or leakage, get full instructions and advice from the maker. An hydrometer, arranged with a rubber bulb to draw a portion of the electrolyte from each cell, furnishes the best indication of the condition of the battery. The hydrometer shows the specific gravity of the electrolyte, which for a fully charged cell should be 1280 on a specific gravity scale. If the car is out of service for a considerable length of time, as when laid up for the winter,

it is necessary to charge the battery at regular intervals. This may be done by running the engine at a car speed of twenty miles per hour for at least one hour every two weeks. If the car is to be stored, and it is not convenient to charge as above, the battery should be removed from the car and placed in a reliable garage to be properly taken care of. If your battery is arranged with terminal posts for the wiring connections these must be examined occasionally to see that they are clean and free from sulphate. The thorough application of a small amount of vaseline at the metal connections to the battery posts will prevent sulphating and consequent corrosion and poor electrical contact at these points.

Tools and Repair Equipment.—In equipping a car for the season's use many factors must be considered, as the character of the supplies and spare parts required will vary with the type and make of car, while the tools needed for repairing the mechanism will depend largely upon the mechanical ability of the car owner or the person in charge of the automobile. While a very complete outfit of tools and spare parts would be the best insurance against trouble, it should be remembered that the weight of the tool outfit should be kept to as low a point as possible. As a general rule comparatively few well chosen tools, that would be apt to be used often, would be superior to an indiscriminately selected bulky outfit by one who has no knowledge of the value of the various appliances or how to use them. In modern motor cars it is easy to find storage room for a very complete assortment of tools and supplies, and while some of these may be considered unnecessary there may be a time when it will be invaluable, especially if much touring is contemplated.

The first point to consider is selecting the common tools that one would be apt to need, and as a guide a very complete tool roll, such as sold by practically all automobile supply houses at a moderate price, is shown. The choice of a container for tools and supplies is very important, and while the tool roll depicted, which is made of heavy canvas or leather, is very useful, it has the disadvantage of being inconvenient to handle. As it must be unrolled every time certain of the tools would be

needed, the ground is usually the only available place for its extension and the contents and casing may become very dirty. The writer prefers to use a tool box in which a number of trays are fitted. These are divided into compartments, each tool having a distinct space, and to insure against rattle or injuring the tools the various compartments may be lined with felt or heavy

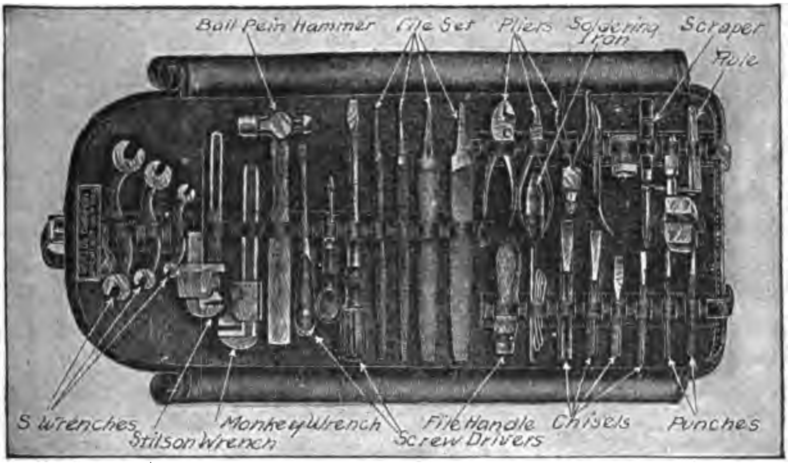


Fig. 68.—Complete Tool Outfit For Repairing Motor Car Mechanism That Occupies But Little Space.

cloth. A very good method of making the trays is to have these composed of or filled in with a wooden block, which is recessed to fit the tools to be carried. A container of this nature is superior to others, as the tools needed most often can be placed in the uppermost tray, making them accessible, while in a roll the tools needed most often may be carried in the center. Some motorists throw the tools indiscriminately into a box and the result is that many of the appliances are damaged by coming in contact with other tools. The cutting edges of cold chisels and wire cutters are nicked, the teeth of files become broken or filled up with dirt, and screw driver points may become quickly blunted, and their utility reduced. At the same time the handles

and polished surfaces of the other tools have become marred by the edges of the cutting tools.

The roll illustrated has a fair assortment of useful tools of good quality. The outfit consists of three screw drivers, three pairs of pliers, three chisels and one center punch, three drift pins, a set of four files, five wrenches, soldering copper and handle, a file handle, a split pin extractor, small roll of wire solder, one three-cornered scraper, a small tin box containing extra split pins or locking cotters and lock washers, and a ball pein hammer. The wrenches include a set of three double open-end spanners, one adjustable monkey wrench and a Stilson or pipe wrench.

A word of caution to motorists who are apt to judge tools merely by the price should be heeded. Many men who are not mechanically informed select even the simpler tools by price rather than quality. As a rule the better quality tools only cost a few cents more and will give satisfactory service during a lifetime, while cheaper ones often cannot endure the work of a single season. Cheap chisels and punches are made of soft, improperly tempered steel; cheap wrenches are made from malleable iron castings, instead of steel drop forgings; low-priced screw drivers have the blades of inferior stock and so flimsily secured in the handle that they will turn on the slightest provocation instead of loosening the screw to which they are applied. The motorist who buys cheap tools is penny wise and pound foolish, and it is better to purchase fewer tools, but good ones, if economy dictates when the purchase is made.

General Supplies.—In addition to the tools enumerated there are many miscellaneous appliances that can be carried to advantage. Some of these are necessary only with certain types of cars, and many of the list which follows may be kept at home except when the car is taken on an extended tour which is apt to end at some distance from a convenient base of supplies.

Funnels to fit the water, gasoline and oil containers should be carried, and it is well to use separate funnels for water, oil and gasoline. That used for water should have a spout the full size of the filler opening in the radiator, and it is desirable that

it should include a wire gauze screen to filter the water of any particles of foreign matter that might clog the circulating system. The oil funnel should be small, and it can be easily carried by nesting in one of the larger funnels. Sometimes a nest of three funnels may be obtained, one fitting in the other, and the entire set of three takes no more room than one funnel would ordinarily. The gasoline funnel should have a chamois skin through which all fuel would pass when filling the tank. This will remove the water and dirt always present in gasoline and is practical insurance against carburetion troubles.

A collapsible rubber water pail is useful on all types of cars, as it may be used to replenish the supply in the radiator from any wayside source when on the road or to carry water to the car for washing hands after repairs have been made. A small box of some good grease-dissolving hand soap, a clean towel and a piece of toilet soap take so little space that they can be stowed away anywhere, and their value is only apparent when a particularly dirty job of tire replacement or car repairing has been necessary on the road. A hand oil can and an oil syringe are needed to lubricate the various parts, the syringe being especially valuable to force oil at points that would not be easily reached with the hand oiler or that would require more lubricant than could be conveniently supplied by that method. A combination funnel and measure is often carried in place of an oil funnel. The supplies needed to wash the car are shown at Fig. 66.

It is well to carry a gallon can of cylinder oil and a small can of cup grease any time that one is touring away from home when there might be doubt of obtaining the same grade generally used on the car. With the ordinary single-chamber type of gasoline tank it will be found advantageous to carry a spare container holding two gallons of fuel. This occupies but little space and is practical insurance against being stalled by lack of fuel. Extra tungsten bulbs are needed if the car is electrically lighted. A small hand search light is useful in looking at the gasoline level at night or in inspecting various points about the car where the presence of gasoline fumes would make the use of a naked flame dangerous. For more extended working after nightfall,

a small portable trouble lamp, which will take its current from the ignition battery, will often demonstrate its worth. A complete set of spark plugs should also be carried.

MOTOR TROUBLES

The following suggestions detail in a brief way the causes most apt to produce faulty automobile engine action and outline defective conditions that may be corrected by the motorist. The instructions refer to the Cole Eight car, but apply equally well to any model of other make having battery ignition. The troubles are enumerated under headings denoting easily recognized symptoms of faulty action.

Stopping of Motor

1. Out of gasoline.
2. Disconnected spark plug cable or other loose electrical connections.
3. Dirty contact points in the distributor or accumulation of oil or dirt on the under side of distributor cover.
4. Out of engine oil, indicated usually by knocking in the motor, followed by an abrupt stop. If this occurs, do not attempt to use either the electric starter or hand crank until the motor has been allowed to cool off. Kerosene should be applied to the interior through the pet cocks while the motor is still warm. This usually is a serious matter, and the motor should have the attention of a good mechanic before attempting to put the car into service again.
5. Can not crank motor. Frozen water pump. Seized motor bearings or pistons, due to lack of oil. Transmission engaged.
6. Leaky float in vacuum tank.

Missing of Motor

1. Short-circuited spark plug. Points not adjusted properly.
2. Partially short-circuited or broken terminals.
3. Poor contact between the various ends and clips of wiring.

4. Loss of compression in one or more cylinders. Valves may be stuck. Valves may need regrinding or reseating. Valve springs may be weak or broken. Cylinder head gasket blown out.
5. Water in gasoline; the motor runs spasmodically. (This is the most difficult to separate from other causes and should be one of the last things looked for.)
6. When motor misses, you may locate the missing cylinder by opening the priming cock on top of the cylinders, one at a time. A sharp hiss will denote an explosion if accompanied with a flame. After replacing the spark plug in the missing one with a new one, or with one from another cylinder, you will have to determine whether missing is caused by defective plugs or wires leading to same. If the trouble is still continuing, turn over the motor slowly by hand in an endeavor to detect a defect in the compression in the different cylinders.
7. If missing is not due to any of the items mentioned above, there may be an air leak between the carburetor and intake manifold, or between the manifold and cylinder block.
8. Wires in the electrical system have been tampered with.

Loss of Power

The motor will not pull on grades or under heavy loads.

1. Loss of compression due to leaky valves.
2. Too rich a mixture through some defect in carburetor, probably flooding due to grit under float valve.
3. Late ignition.
4. Lack of water in radiator or oil in motor, causing the motor to run hot.
5. Lack of gasoline. If lack of gasoline through stoppage of pipe, the motor will spit back through carburetor when throttle is opened.
6. Poor grade of gasoline, in cold weather, causing too weak a mixture.
7. Dragging brakes. See that the car can be rolled by hand

easily or that it will coast down hill when clutch is released and not slow down. Feel the brake drum with your hand to determine overheating.

8. Flat tires.
9. Stoppage of the jets in carburetor, due to dirt or sediment in gasoline.
10. Carbon deposits in combustion chamber.

Motor Will Not Start

1. Switch not turned on, or defective contact in switch.
2. Gasoline not turned on, or out of gasoline.
3. Poor grade of gasoline in cold weather, or water in gasoline.
4. Weak ignition, due to depleted storage battery.
5. If the motor turns over very slowly, your storage battery has become depleted, due to continuous cranking or prolonged burning of the lamps, with insufficient running of the motor or lack of care in filling battery with distilled water. If there is good, clean gasoline in the carburetor, and a good spark at the plugs, motor will start if properly handled.
6. Broken ground wire from battery.

Motor Knocks

1. Spark advanced too far.
2. Too rich a mixture.
3. Motor speed too low in pulling on hills or through bad roads; on direct drive, shift to a lower speed. Loose connecting rod bearings. (Light knock at high speed.)
4. Crankshaft bearing loose. Heavy pounding at low motor speeds and under heavy loads.
5. Too much play in valve push rods. (Light tapping sound.)
6. Tapping noise due to improper adjustment.
7. Carbon in cylinders.

Water in Radiator Boils

1. Low supply of water.
2. Too rich a mixture of gasoline.

3. Carbonized cylinders.
4. Lack of motor oil.
5. Late ignition or retarded spark.
6. Broken or inoperative pump.
7. Radiator core stopped up with mud or other matter.
8. Fan belt slipping.

Motor Will Not Stop with Switch Off

Overheated. If, because of lack of water in circulating system, motor will become sluggish, run slowly and pound. Close gasoline adjustment in carburetor. Throw in high gear, lock emergency brake and let in clutch. This will stall the engine.

Carbon in Cylinders

With this condition water does not necessarily reach the boiling point. The carbon deposit inside the combustion chamber becomes incandescent and fires the charge when compressed. Have carbon removed by scraping.

Tire Repair and Maintenance.—Of the causes of pneumatic tire failure the most common is natural wear of the tread portion of the tire. The rubber compound in contact with the road surface wears away in time, and the fabric layers which constitute the breaker strips are exposed. The shoe is weakened and any sharp object in the road is apt to penetrate the weakened case and puncture the inner tube. If a number of the layers of fabric comprising the body of the shoe are cut, this constitutes a weak place in the casing and a blow-out will result, because the few layers of fabric remaining do not have sufficient strength to resist the air pressure.

A stone bruise is caused by the removal of a portion of the rubber tread by a sharp stone, piece of glass, etc., and is much more serious than a puncture because it removes some of the tire, whereas in ordinary cases of puncture a sharp object merely penetrates the casing. A sand blister is produced by sand or grit from the road working into a space in the tire between the tread and the fabric body through some neglected incision or

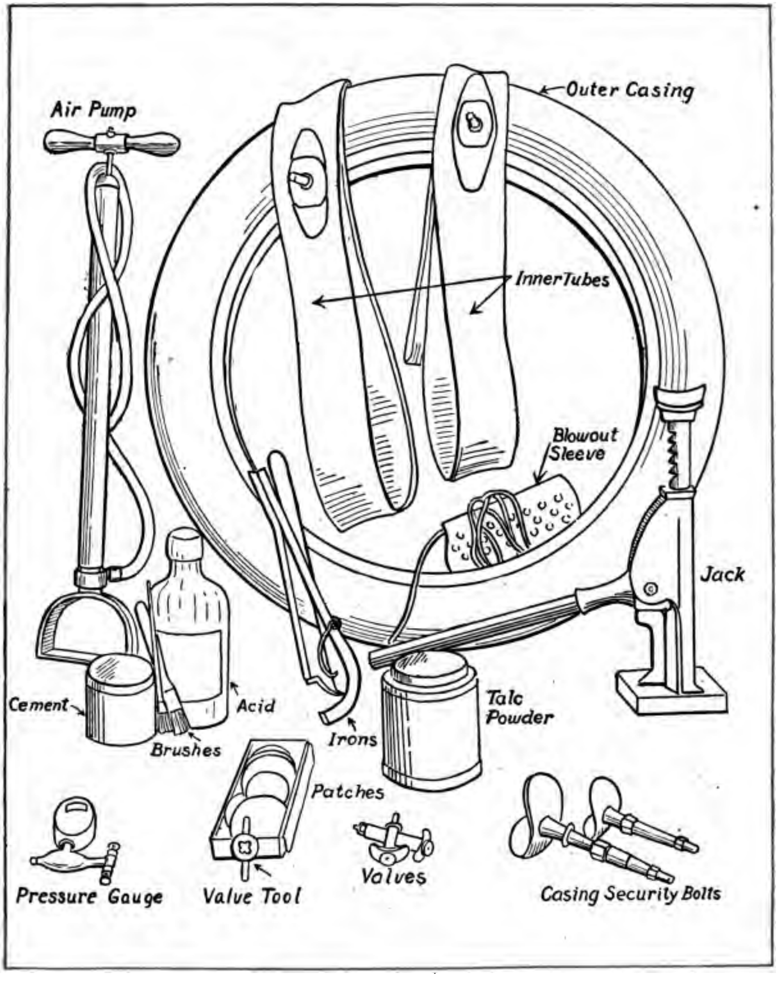


Fig. 69.—Spare Parts and Necessary Repair Equipment for Automobiles Using Pneumatic Tires.

bruise. The side of the tread is often chafed by running the tires against curb stones or by driving in car tracks. Rim cutting is generally caused by insufficient inflation, which permits the rim to cut into the tire and thus tends to sever the bead from the side of the shoe.

The chief inner tube trouble is penetration of the wall by

some sharp object, or the folding over of part of the tube walls when the tire was applied. The parts of the check valve sometimes give trouble and the valve leaks. In cases of valve trouble it is usually cheaper to replace the valve inside than it is to attempt to fix it. Some of the causes of valve leakage are hardening of the rubber washer; bent stem, which prevents the valve from seating properly, or a particle of dust or other foreign matter which would act to keep the valve from closing the air passage positively.

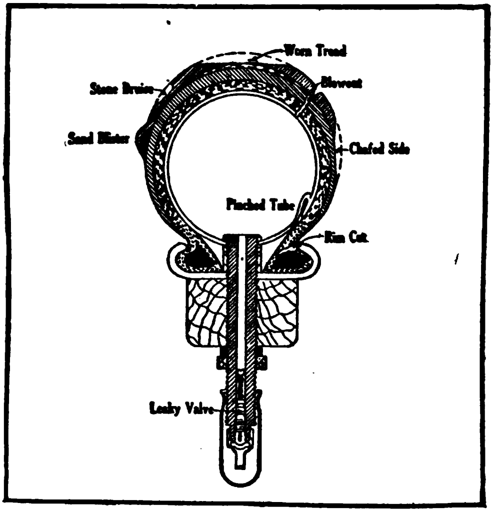


Fig. 70.—Sectional View of Pneumatic Tire Showing Defective Conditions.

The most serious condition that a motorist will meet with is a "blow-out," and usually only temporary repairs can be made on the road. This condition can be overcome by the use of an inside patch to reinforce the ruptured portion and prevent the inner tube from bursting or chafing through. An outside patch can be applied to strengthen the casing and keep the dirt from working into the tire.

Inner tube punctures may be repaired temporarily by patching. After the area surrounding the puncture is thoroughly cleaned with gasoline and roughened with sand paper or emery cloth, a coat of patching cement is applied to both patch and tube. This is allowed to become thoroughly dry before the second coat is applied. The second coat is allowed to become "tacky," which expresses a condition where the cement is almost dry and yet still possesses a certain degree of adhesiveness. The patch is applied to the cemented portion of the tube and the

whole is clamped firmly together to secure positive adhesion while the cementing medium is drying. Patches should always be of sufficient size to cover the damaged portion and at the same time have about three quarters of an inch or more of the patch at all sides of the orifice.

Very satisfactory repairs to both inner tubes and outer casings of a permanent nature can be made by using small portable vulcanizers, which may be heated by either electricity or vapor. When these are used a special vulcanizing cement is necessary and uncured rubber stock must be used for patching or filling openings caused by punctures or blow-outs. The patch of raw material is applied to the cemented surface of the tube or casing and the vulcanizer heated to the proper temperature. The heat of the vulcanizer causes the rubber of the patch to unite perfectly with the old material and forms an intimate bond.

It is necessary in all cars using pneumatic tires to carry a certain amount of equipment for handling and repairing these on the road. A typical outfit is shown at Fig. 69, this consisting of a spare outer casing, two extra inner tubes for replacement purposes, a blow-out sleeve, a number of patches, and an acid-cure vulcanizing outfit for applying them. Tire irons must be provided to remove the casing from the rim; the jack is used to raise the wheel of the vehicle on which the defective tire is installed from the ground and make it possible to remove the tire completely from the wheel. The air pump is needed to inflate the repaired tube or the new member inserted to take its place. The talcum powder is sprinkled between the casing and the tube to prevent chafing or heating, while the spare valves and valve tool will be found useful in event of damage to that important component of the inner tube. As it is desirable to inflate the tires to a certain definite pressure, a small gage which will show the amount of compression in the tire is useful.

Next to the selection of proper size tires, the important consideration is that these be kept properly inflated. If a tire is not properly filled with air it will flatten out, and the tendency will be to separate the layers of fabric and rubber of which the

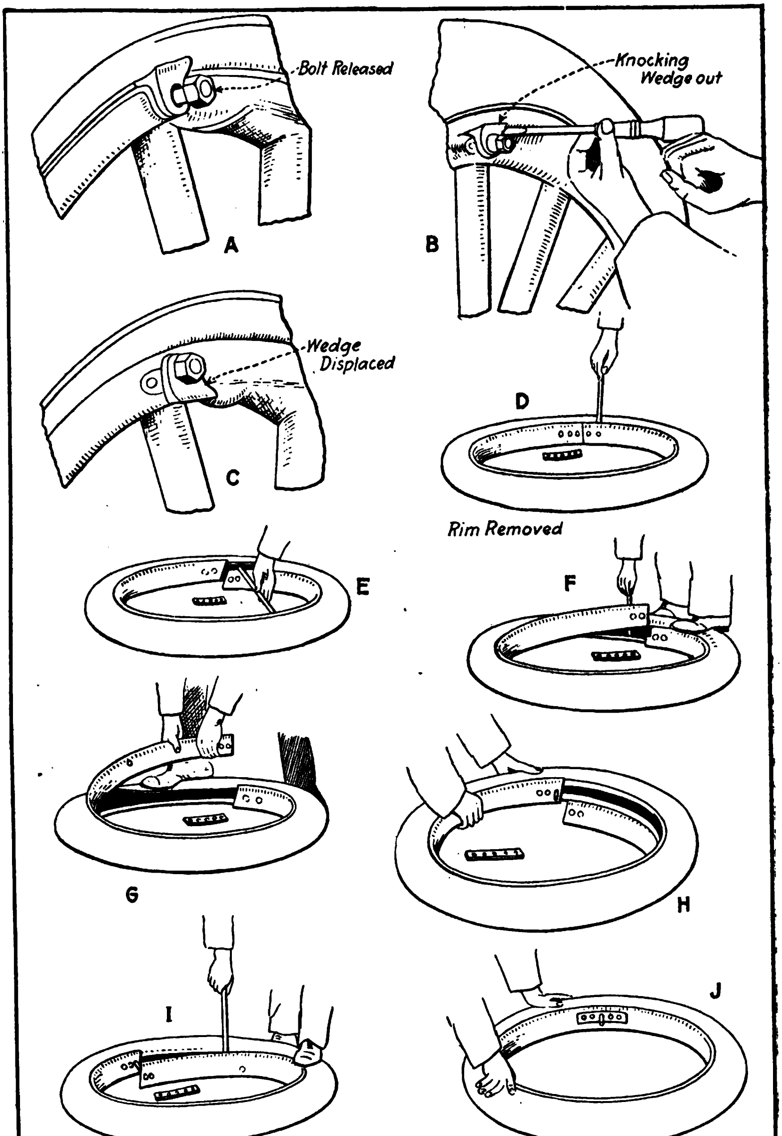


Fig. 71.—How to Remove a Demountable Rim From the Wheel and to Dismantle and Reassemble the Rim and Tire Casing.

shoe is composed, because of the alteration of the almost round or tubular section that the tire is supposed to be when in use. If a tire is properly inflated, the walls will be braced from inside by the pressure of the compressed air in the inner tube, and the flattening effect will have no perceptible effect in producing disintegration of the fabric and rubber plies of the casing. The figures given in table are those recommended by leading tire manufacturers as being most suitable for the various sizes of tires listed.

Air Pressures for Inflating Pneumatic Tires Recommended by Leading Makers

Width of Tire, Inches.	Maximum Weight on Wheel, Lbs.	Air Pressure in Tire, Lbs. per Square Inch.
2½	225	50
3	350	60
3½	600	70
4	750	80
4½	1,000	90
5	1,000	90

The conventional method of inflating tires by using a foot pump does not always insure that the tire will receive adequate inflation, and when a pump is employed it is imperative that some form of gage be provided that will register the amount of pressure inside of the tire in order that it will reach the figure recommended by the tire makers. Different methods of tire inflation have been devised which eliminate the necessity of using manually operated pumps. Obviously a simple expedient would be to provide a small power-driven pump that could be actuated by any convenient mechanical connection with the engine. Another method is to use an air bottle, which is a steel container in which air is stored under great pressure. The air is compressed to such a point that a tank less than two feet long and six inches in diameter will furnish sufficient air to inflate seven or eight tires of average size, or twelve to fourteen small ones. The tanks may be exchanged at small expense when

exhausted for new containers holding a fresh supply of air. In some tanks gases of various kinds under high pressure are used and the motorist may obtain these on the same basis as air bottles are supplied.

All devices of this character are fitted with gages to indicate the amount of pressure in the tire, and to prevent overinflation. If a tire is not properly inflated the shoe will be liable to various kinds of road damage and will be easily punctured, while if the pressure is too high the shoe is liable to "blow-out" at any weak point in the structure.

The rules to secure satisfactory operation from pneumatic tires may be easily summed up. In the first place, it is imperative that the tires be inflated to the pressures recommended by the manufacturers and that they be selected with a certain margin of safety over the actual requirements. The tires should be kept clean and free from oil or grease, because the oleaginous substances used for lubrication very quickly attack rubber compounds and cause crumbling and rapid deterioration. Oil or grease should be wiped off as soon as noticed and the tire cleaned by the application of gasoline. Any small cuts or openings in the tire that may permit water to enter or sand to work between the fabric and the tread will cause trouble in time. One should be careful in driving not to apply the brakes too suddenly, because this will lock the wheels and wear the tire very quickly. Care should be taken not to drive in car tracks, and when highways do not have the proper surface they should be negotiated very carefully to avoid cutting the casings.

Extricating a Mired Automobile.—Highway conditions are not always of the best during the winter and early spring, especially on those unimproved dirt roads where there is considerable traffic. While simple and light block and tackle outfits that are undergeared so they can be operated with but little exertion by any person of average strength may be procured on the open market, these are not generally known to automobilists and their merits are not recognized because they are not apt to be needed under ordinary touring conditions. However, any motorist is apt to be stuck in the mud or sand at some time or other, so a

brief discussion of some of the methods used by others in getting out of a similar predicament may be of value.

Experience has shown that for sand, the use of ordinary oat sacks is excellent. Three of these sacks are tied around each rear wheel, as shown in accompanying illustration, forming equi-

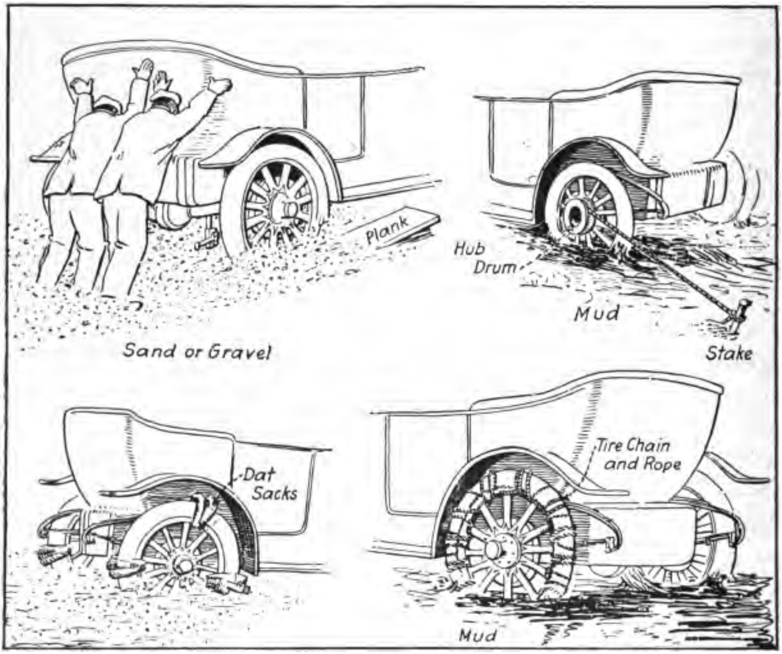


Fig. 72.—Methods of Extricating Mired Automobile.

distantly spaced lumps on the wheels. The speed lever is thrown in low gear and the clutch engaged slowly. This method has been tried by a number of tourists, among which may be mentioned road scouts, with great success. Another method, but one which requires more work, is to get two planks of wood and place one under each wheel, as shown in the illustration at *B*. The planks should be placed as far under the wheels as possible. If planks are not available, brush or boughs may be strewn on the soft ground under the wheels, or stones laid to form a tem-

porary roadway. The work may be made easier by jacking up the wheels, but this is not always possible. In using the jack where the axle is only a few inches from the ground, dig a hole and place a brick or a block of wood at the bottom. Then place the jack on the block. With the planks under the wheels, one or more men should push the car while a third does the driving. The motor should not be raced and the clutch should be engaged slowly. Some resort to the method of simply deflating the tires. Others carry strips of heavy canvas to place under the wheels.

The best way to get a car out of a deep mud hole, if no hub drum is fitted, is to get a team of horses. However, a method which has been used with much success consists in placing the tire chains on both wheels, then winding rope around the tire. The use of a detachable hub drum is advisable and there are several marketed that can be fitted to standard cars. The use of a hub drum winch is shown herewith. Any substantial anchorage, such as a tree, fence post, etc., can be used instead of the stake shown, though a piece of steel tube or sharpened steel shaft, one inch in diameter and three feet long, may be carried in the car for this purpose, as accommodating trees and posts are not always at hand

INDEX

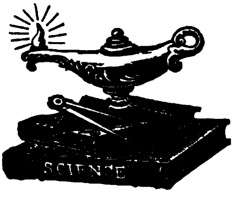
CATALOGUE

Of the LATEST and BEST

PRACTICAL and MECHANICAL

BOOKS

Including Automobile and Aviation Books



Any of these books will be sent prepaid to any part of the world, on receipt of price. Remit by Draft, Postal Order, Express Order or Registered Letter

Published and For Sale By

The Norman W. Henley Publishing Co.,

2 West 45th Street, New York, U.S.A.

INDEX

HOW TO REMIT—By Postal Money Order, Express Money Order, Bank Draft or Registered Letter.

AUTOMOBILES AND MOTORCYCLES

The Modern Gasoline Automobile—Its Design, Construction, and Operation, 1918 Edition. By VICTOR W. PAGÉ, M.S.A.E.

This is the most complete, practical and up-to-date treatise on gasoline automobiles and their component parts ever published. In the new *revised* and *enlarged* 1918 *edition*, all phases of automobile construction, operation and maintenance are fully and completely described, and in language anyone can understand. Every part of all types of automobiles, from light cyclecars to heavy motor trucks and tractors, are described in a thorough manner, not only the automobile, but every item of it; equipment, accessories, tools needed, supplies and spare parts necessary for its upkeep, are fully discussed.
It is clearly and concisely written by an expert familiar with every branch of the automobile industry and the originator of the practical system of self-education on technical subjects. It is a liberal education in the automobile art, useful to all who motor for either business or pleasure.
Anyone reading the incomparable treatise is in touch with all improvements that have been made in motor-car construction. All latest developments, such as high speed aluminum motors and multiple valve and sleeve-valve engines, are considered in detail. The latest ignition, carburetor and lubrication practice is outlined. New forms of change speed gears, and final power transmission systems, and all latest chassis improvements are shown and described. This book is used in all leading automobile schools and is conceded to be the STANDARD TREATISE. The chapter on Starting and Lighting Systems has been greatly enlarged, and many automobile engineering features that have long puzzled laymen are explained so clearly that the underlying principles can be understood by anyone. This book was first published six years ago and so much new matter has been added that it is nearly twice its original size. The only treatise covering various forms of war automobiles and recent developments in motor-truck design as well as pleasure cars. *This book is not too technical for the layman nor too elementary for the more expert. It is an incomparable work of reference for home or school.* 1,000 6x9 pages, nearly 1,000 illustrations, 12 folding plates. Cloth bound. Price **$3.00**

WHAT IS SAID OF THIS BOOK:

"It is the best book on the Automobile seen up to date."—J. H. Pile, Associate Editor *Automobile Trade Journal.*
"Every Automobile Owner has use for a book of this character."—*The Tradesman.*
"This book is superior to any treatise heretofore published on the subject."—*The Inventive Age.*
"We know of no other volume that is so complete in all its departments, and in which the wide field of automobile construction with its mechanical intricacies is so plainly handled, both in the text and in the matter of illustrations."—*The Motorist.*
"The book is very thorough, a careful examination failing to disclose any point in connection with the automobile, its care and repair, to have been overlooked."—*Iron Age.*
"Mr. Pagé has done a great work, and benefit to the Automobile Field."—W. C. Hasford, Mgr. Y. M. C. A. Automobile School, Boston, Mass.
"It is just the kind of a book a motorist needs if he wants to understand his car."—*American Thresherman.*

The Model T Ford Car, Its Construction, Operation and Repair. By VICTOR W. PAGÉ, M.S.A.E.

This is a complete instruction book. All parts of the Ford Model T Car are described and illustrated; the construction is fully described and operating principles made clear to everyone. Every Ford owner needs this practical book. You don't have to guess about the construction or where the trouble is, as it shows how to take all parts apart and how to locate and fix all faults. The writer, Mr. Pagé, has operated a Ford car for many years and writes from actual knowledge. Among the contents are: 1. The Ford Car: Its Parts and Their Functions. 2. The Engine and Auxiliary Groups. How the Engine Works—The Fuel Supply System—The Carburetor—Making the Ignition Spark—Cooling and Lubrication. 3. Details of Chassis. Change Speed Gear—Power Transmission—Differential Gear Action—Steering Gear—Front Axle—Frame and Springs—Brakes. 4. How to Drive and Care for the Ford. The Control System Explained—Starting the Motor—Driving the Car—Locating Roadside Troubles—Tire Repairs—Oiling the Chassis—Winter Care of Car. 5. Systematic Location of Troubles and Remedies. Faults in Engine—Faults in Carburetor—Ignition Troubles—Cooling and Lubrication System Defects—Adjustment of Transmission Gear—General Chassis Repairs. 95 illustrations, 300 pages, 2 large folding plates. Price **$1.00**

Automobile Repairing Made Easy. By VICTOR W. PAGÉ, M.S.A.E.

A comprehensive, practical exposition of every phase of modern automobile repairing practice. Outlines every process incidental to motor car restoration. Gives plans for workshop construction, suggestions for equipment, power needed, machinery and tools necessary to carry on business successfully. Tells how to overhaul and repair all parts of all automobiles. Everything is explained so simpy that motorists and students can acquire a full working knowledge of automobile repairing. This work starts with the engine, then considers carburetion, ignition, cooling and lubrication systems. The clutch, change speed gearing and transmission system are considered in detail. Contains instructions for repairing all types of axles, steering gears and other chassis parts. Many tables, short cuts in figuring and rules of practice are given for the mechanic. Explains fully valve and magneto timing, "tuning" engines, systematic location of trouble, repair of ball and roller bearings, shop kinks, first aid to injured and a multitude of subjects of interest to all in the garage and repair business. *This book contains special instructions on electric starting, lighting and ignition systems, tire repairing and rebuilding, autogenous welding, brazing and soldering, heat treatment of steel, latest timing practice, eight and twelve-cylinder motors, etc.* 5¾x8. Cloth. 1,056 pages, 1,000 illustrations, 11 folding plates. Price **$3.00**

WHAT IS SAID OF THIS BOOK:

"'Automobile Repairing Made Easy' is the best book on the subject I have ever seen and the only book I ever saw that is of any value in a garage."—Fred Jeffrey, Martinsburg, Neb.
"I wish to thank you for sending me a copy of 'Automobile Repairing Made Easy.' I do not think it could be excelled."—S. W. Gisriel, Director of Instruction, Y. M. C. A., Philadelphia, Pa.

Questions and Answers Relating to Modern Automobile Construction, Driving and Repair. By VICTOR W. PAGÉ, M.S.A.E.

A practical self-instructor for students, mechanics and motorists, consisting of thirty-seven lessons in the form of questions and answers, written with special reference to the requirements of the non-technical reader desiring easily understood, explanatory matter relating to all branches of automobiling. The subject-matter is absolutely correct and explained in simple language. If you can't answer all of the following questions, you need this work. The answers to these and over 2,000 more are to be found in its pages. Give the name of all important parts of an automobile and describe their functions. Describe action of latest types of kerosene carburetors. What is the difference between a "double" ignition system and a "dual" ignition system? Name parts of an induction coil. How are valves timed? What is an electric motor starter and how does it work? What are advantages of worm drive gearing? Name all important types of ball and roller bearings. What is a "three-quarter" floating axle? What is a two-speed axle? What is the Vulcan electric gear shift? Name the causes of lost power in automobiles. Describe all noises due to deranged mechanism and give causes. How can you adjust a carburetor by the color of the exhaust gases? What causes "popping" in the carburetor? What tools and supplies are needed to equip a car? How do you drive various makes of cars? What is a differential lock and where is it used? Name different systems of wire wheel construction, etc., etc. A popular work at a popular price. 5½x7½. Cloth. 650 pages, 350 illustrations, 3 folding plates. Price **$1.50**

WHAT IS SAID OF THIS BOOK:

"If you own a car—get this book."—*The Glassworker.*

"Mr. Page has the faculty of making difficult subjects plain and understandable."—*Bristol Press.*

"We can name no writer better qualified to prepare a book of instruction on automobiles than Mr. Victor W. Pagé."—*Scientific American.*

"The best automobile catechism that has appeared."—*Automobile Topics.*

"There are few men, even with long experience, who will not find this book useful. Great pains have been taken to make it accurate. Special recommendation must be given to the illustrations, which have been made specially for the work. Such excellent books as this greatly assist in fully understanding your automobile."—*Engineering News.*

Modern Starting, Lighting and Ignition Systems. By Victor W. Pagé, M.E.

This practical volume has been written with special reference to the requirements of the non-technical reader desiring easily understood, explanatory matter, relating to all types of automobile ignition, starting and lighting systems. It can be understood by anyone, even without electrical knowledge, because elementary electrical principles are considered before any attempt is made to discuss features of the various systems. These basic principles are clearly stated and illustrated with simple diagrams. *All the leading systems of starting, lighting and ignition have been described and illustrated with the co-operation of the experts employed by the manufacturers.* Wiring diagrams are shown in both technical and non-technical forms. All symbols are fully explained. It is a comprehensive review of modern starting and ignition system practice, and includes a complete exposition of storage battery construction, care and repair. All types of starting motors, generators, magnetos, and all ignition or lighting system-units are fully explained. *Every person in the automobile business needs this volume.* Among some of the subjects treated are: I.—Elementary Electricity; Current Production; Flow; Circuits; Measurements; Definitions; Magnetism; Battery Action; Generator Action. II.—Battery Ignition Systems. III.—Magneto Ignition Systems. IV.—Elementary Exposition of Starting System Principles. V.—Typical Starting and Lighting Systems; Practical Application; Wiring Diagrams; Auto-lite, Bijur, Delco, Dyneto-Entz, Gray and Davis, Remy, U. S. L., Westinghouse, Bosch-Rushmore, Genemotor, North-East, etc. VI.—Locating and Repairing Troubles in Starting and Lighting Systems. VII.—Auxiliary. Electric Systems; Gear-shifting by Electricity; Warning Signals; Electric Brake; Entz-Transmission, Wagner-Saxon Circuits, Wagner-Studebaker Circuits. 5¼x7½. Cloth. 530 pages, 297 illustrations, 3 folding plates.
Price **$1.50**

Automobile Welding With the Oxy-Acetylene Flame. By M. Keith Dunham.

This is the only complete book on the "why" and "how" of Welding with the Oxy-Acetylene Flame, and from its pages one can gain information so that he can weld anything that comes along.
No one can afford to be without this concise book, as it first explains the apparatus to be used, and then covers in detail the actual welding of all automobile parts. The welding of aluminum, cast iron, steel, copper, brass and malleable iron is clearly explained, as well as the proper way to burn the carbon out of the combustion head of the motor. Among the contents are: Chapter I.—Apparatus Knowledge. Chapter II.—Shop Equipment and Initial Procedure. Chapter III.—Cast Iron. Chapter IV.—Aluminum. Chapter V.—Steel. Chapter VI.—Malleable Iron, Copper, Brass, Bronze. Chapter VII.—Carbon Burning and other Uses of Oxygen and Acetylene. Chapter VIII.—How to Figure Cost of Welding. 167 pages, fully illustrated. Price **$1.00**

Storage Batteries Simplified. By Victor W. Pagé, M.S.A.E.

A comprehensive treatise devoted entirely to secondary batteries and their maintenance, repair and use.
This is the most up-to-date book on this subject. Describes fully the Exide, Edison, Gould, Willard, U. S. L. and other storage battery forms in the types best suited for automobile, stationary and marine work. Nothing of importance has been omitted that the reader should know about the practical operation and care of storage batteries. No details have been slighted. The instructions for charging and care have been made as simple as possible. Brief Synopsis of Chapters: Chapter I.—Storage Battery Development; Types of Storage Batteries; Lead Plate Types; The Edison Cell. Chapter II.—Storage Battery Construction; Plates and Girds; Planté Plates; Fauré Plates; Non-Lead Plates; Commercial Battery Designs. Chapter III.—Charging Methods; Rectifiers; Converters; Rheostats; Rules for Charging. Chapter IV.—Battery Repairs and Maintenance. Chapter V.—Industrial Application of Storage Batteries; Glossary of Storage Battery Terms. 208 Pages. Very Fully Illustrated. Price . . . . **$1.50 net**

How to Run an Automobile. By Victor W. Pagé, M.S.A.E.

This treatise gives concise instructions for starting and running all makes of gasoline automobiles, how to care for them, and gives distinctive features of control. Describes every step for shifting gears, controlling engines, etc. Among the chapters contained are: I.—Automobile Parts and Their Functions. II.—General Starting and Driving Instructions. III.—Typical 1917 Control Systems. IV.—Care of Automobiles. 178 pages. 72 specially made illustrations. Price **$1.00**

The Automobilist's Pocket Companion and Expense Record. Arranged by VICTOR W. PAGÉ, M.S.A.E.

This book is not only valuable as a convenient cost record but contains much information of value to motorists. Includes a condensed digest of auto laws of all States, a lubrication schedule, hints for care of storage battery and care of tires, location of road troubles, anti-freezing solutions, horse-power table, driving hints and many useful tables and recipes of interest to all motorists. Not a technical book in any sense of the word, just a collection of practical facts in simple language for the everyday motorist. Price **$1.00**

Motorcycles, Side Cars and Cyclecars; their Construction, Management and Repair. By VICTOR W. PAGÉ, M.S.A.E.

The only complete work published for the motorcyclist and cyclecarist. Describes fully all leading types of machines, their design, construction, maintenance, operation and repair. This treatise outlines fully the operation of two- and four-cycle power plants and all ignition, carburetion and lubrication systems in detail. Describes all representative types of free engine clutches, variable speed gears and power transmission systems. Gives complete instructions for operating and repairing all types. Considers fully electric self-starting and lighting systems, all types of spring frames and spring forks and shows leading control methods. For those desiring technical information a complete series of tables and many formulæ to assist in designing are included. The work tells how to figure power needed to climb grades, overcome air resistance and attain high speeds. It shows how to select gear ratios for various weights and powers, how to figure braking efficiency required, gives sizes of belts and chains to transmit power safely, and shows how to design sprockets, belt pulleys, etc. This work also includes complete formulæ for figuring horse-power, shows how dynamometer tests are made, defines relative efficiency of air and water-cooled engines, plain and anti-friction bearings and many other data of a practical, helpful, engineering nature. Remember that you get this information in addition to the practical description and instructions which alone are worth several times the price of the book. 550 pages. 350 specially made illustrations, 5 folding plates. Cloth. Price **$1.50**

AUTOMOBILE AND MOTORCYCLE CHARTS

Chart. Location of Gasoline Engine Troubles Made Easy—A Chart Showing Sectional View of Gasoline Engine. Compiled by VICTOR W. PAGÉ, M.S.A.E.

It shows clearly all parts of a typical four-cylinder gasoline engine of the four-cycle type. It outlines distinctly all parts liable to give trouble and also details the derangements apt to interfere with smooth engine operation.
Valuable to students, motorists, mechanics, repairmen, garagemen, automobile salesmen, chauffeurs, motorboat owners, motor-truck and tractor drivers, aviators, motor-cyclists, and all others who have to do with gasoline power plants.
It simplifies location of all engine troubles, and while it will prove invaluable to the novice, it can be used to advantage by the more expert. It should be on the walls of every public and private garage, automobile repair shop, club house or school. It can be carried in the automobile or pocket with ease, and will insure against loss of time when engine trouble manifests itself.
This sectional view of engine is a complete review of all motor troubles. It is prepared by a practical motorist for all who motor. More information for the money than ever before offered. No details omitted. Size 25x38 inches. Securely mailed on receipt of **25 cents**

Chart. Location of Carbureton Troubles Made Easy. Compiled by VICTOR W. PAGÉ, M.S.A.E.

This chart shows all parts of a typical pressure feed fuel supply system and gives causes of trouble, how to locate defects and means of remedying them. Size 24x38 inches. Price . . . . **25 cents**

Chart. Location of Ford Engine Troubles Made Easy. Compiled by VICTOR W. PAGÉ, M.S.A.E.

This shows clear sectional views depicting all portions of the Ford power plant and auxiliary groups. It outlines clearly all parts of the engine, fuel supply system, ignition group and cooling system, that are apt to give trouble, detailing all derangements that are liable to make an engine lose power, start hard or work irregularly. This chart is valuable to students, owners, and drivers, as it simplifies location of all engine faults. Of great advantage as an instructor for the novice, it can be used equally well by the more expert as a work of reference and review. It can be carried in the tool-box or pocket with ease and will save its cost in labor eliminated the first time engine trouble manifests itself. Prepared with special reference to the average man's needs and is a practical review of all motor troubles because it is based on the actual experience of an automobile engineer-mechanic with the mechanism the chart describes. It enables the non-technical owner or operator of a Ford car to locate engine derangements by systematic search, guided by easily recognized symptoms instead of by guesswork. It makes the average owner independent of the roadside repair shop when touring. Must be seen to be appreciated. Size 25x38 inches. Printed on heavy bond paper. Price . . . . **25 cents**

Chart. Lubrication of the Motor Car Chassis. Compiled by VICTOR W. PAGÉ, M.S.A.E.

This chart presents the plan view of a typical six-cylinder chassis of standard design and all parts are clearly indicated that demand oil, also the frequency with which they must be lubricated and the kind of oil to use. A practical chart for all interested in motor-car maintenance. Size 24x38 inches. Price . . . . **25 cents**

Chart. Location of Ignition System Troubles Made Easy. Compiled by VICTOR W. PAGÉ, M.S.A.E.

In this diagram all parts of a typical double ignition system using battery and magneto current are shown, and suggestions are given for readily finding ignition troubles and eliminating them when found. Size 24x38 inches. Price . . . . **25 cents**

Chart. Location of Cooling and Lubrication System Faults. Compiled by VICTOR W. PAGÉ, M.S.A.E.

This composite diagram shows a typical automobile power plant using pump circulated water-cooling system and the most popular lubrication method. Gives suggestions for curing all overheating and loss of power faults due to faulty action of the oiling or cooling group. Size 24x38 inches. Price . . . . **25 cents**

Chart. Motorcycle Troubles Made Easy. Compiled by VICTOR W. PAGÉ, M.S.A.E.

A chart showing sectional view of a single-cylinder gasoline engine. This chart simplifies location of all power-plant troubles. A single-cylinder motor is shown for simplicity. It outlines distinctly all parts liable to give trouble and also details the derangements apt to interfere with smooth engine operation. This chart will prove of value to all who have to do with the operation, repair or sale of motorcycles. No details omitted. Size 30x20 inches. Price . . . . **25 cents**

AVIATION

Aviation Engines, their Design, Construction, Operation and Repair. By Lieut. VICTOR W. PAGÉ, Aviation Section, S.C.U.S.R.

A practical work containing valuable instructions for aviation students, mechanicians, squadron engineering officers and all interested in the construction and upkeep of airplane power plants.

The rapidly increasing interest in the study of aviation, and especially of the highly developed internal combustion engines that make mechanical flight possible, has created a demand for a text-book suitable for schools and home study that will clearly and concisely explain the

workings of the various aircraft engines of foreign and domestic manufacture.
This treatise, written by a recognized authority on all of the practical aspects of internal combustion engine construction, maintenance and repair fills the need as no other book does. The matter is logically arranged; all descriptive matter is simply expressed and copiously illustrated so that anyone can understand airplane engine operation and repair even if without previous mechanical training. This work is invaluable for anyone desiring to become an aviator or aviation mechanician.
The latest rotary types, such as the Gnome, Monosoupape, and Le Rhone, are fully explained, as well as the recently developed Vee and radial types. The subjects of carburetion, ignition, cooling and lubrication also are covered in a thorough manner. The chapters on repair and maintenance are distinctive and found in no other book on this subject.
Invaluable to the student, mechanic and soldier wishing to enter the aviation service.
Not a technical book, but a practical, easily understood work of reference for all interested in aeronautical science. 576 octavo pages. 253 specially made engravings. Price . **$3.00 net**

GLOSSARY OF AVIATION TERMS

Termes D'Aviation, English-French, French-English. Compiled by Lieuts. VICTOR W. PAGÉ, A.S., S.C.U.S.R., and PAUL MONTARIOL of the French Flying Corps, on duty on Signal Corps Aviation School, Mineola, L. I.

A complete, well illustrated volume intended to facilitate conversation between English-speaking and French aviators. A very valuable book for all who are about to leave for duty overseas.
Approved for publication by Major W. G. Kilner, S.C., U.S.C.O. Signal Corps Aviation School. Hazlehurst Field, Mineola, L. I.
This book should be in every Aviator's and Mechanic's Kit for ready reference. 128 pages. Fully illustrated with detailed engravings. Price **$1.00**

Aviation Chart. Location of Airplane Power Plant Troubles Made Easy. By Lieut. VICTOR W. PAGÉ, A.S., S.C.U.S.R.

A large chart outlining all parts of a typical airplane power plant, showing the points where trouble is apt to occur and suggesting remedies for the common defects. Intended especially for Aviators and Aviation Mechanics on School and Field Duty. Price . . **50 cents**

BRAZING AND SOLDERING

Brazing and Soldering. By JAMES F. HOBART.

The only book that shows you just how to handle any job of brazing or soldering that comes along; it tells you what mixture to use, how to make a furnace if you need one. Full of valuable kinks. The fifth edition of this book has just been published, and to it much new matter and a large number of tested formulæ for all kinds of solders and fluxes have been added. Illustrated. Price . . . . **25 cents**

CHARTS

Aviation Chart. Location of Airplane Power Plant Troubles Made Easy. By Lieut. VICTOR W. PAGÉ, A.S., S.C.U.S.R.

A large chart outlining all parts of a typical airplane power plant, showing the points where trouble is apt to occur and suggesting remedies for the common defects. Intended especially for Aviators and Aviation Mechanics on School and Field Duty. Price . . . . **50 cents**

Lubrication of the Motor Car Chassis.

This chart presents the plan view of a typical six-cylinder chassis of standard design and all parts are clearly indicated that demand oil, also the frequency with which they must be lubricated and the kind of oil to use. A practical chart for all interested in motor-car maintenance. Size 24x38 inches. Price . . . . **25 cents**

Gasoline Engine Troubles Made Easy—A Chart Showing Sectional View of Gasoline Engine. Compiled by Lieut. VICTOR W. PAGÉ, A.S., S.C.U.S.R.

It shows clearly all parts of a typical four-cylinder gasoline engine of the four-cycle type. It outlines distinctly all parts liable to give trouble and also details the derangements apt to interfere with smooth engine operation.
Valuable to students, motorists, mechanics, repairmen, garagemen, automobile salesmen, chauffeurs, motor-boat owners, motor-truck and tractor drivers, aviators, motor-cyclists, and all others who have to do with gasoline power plants.
It simplifies location of all engine troubles, and while it will prove invaluable to the novice, it can be used to advantage by the more expert. It should be on the walls of every public and private garage, automobile repair shop, club house or school. It can be carried in the automobile or pocket with ease and will insure against loss of time when engine trouble manifests itself.
This sectional view of engine is a complete review of all motor troubles. It is prepared by a practical motorist for all who motor. No details omitted. Size 25x38 inches. Price **25 cents**

Location of Carburetion Troubles Made Easy.

This chart shows all parts of a typical pressure feed fuel supply system and gives causes of trouble, how to locate defects and means of remedying them. Size 24x38 inches. Price . . . . **25 cents**

Location of Ignition System Troubles Made Easy.

In this chart all parts of a typical double ignition system using battery and magneto current are shown and suggestions are given for readily finding ignition troubles and eliminating them when found. Size 24x38 inches. Price . . . . **25 cents**

Location of Cooling and Lubrication System Faults.

This composite chart shows a typical automobile power plant using pump circulated water-cooling system and the most popular lubrication method. Gives suggestions for curing all overheating and loss of power faults due to faulty action of the oiling or cooling group. Size 24x38 inches. Price . . . . **25 cents**

Motorcycle Troubles Made Easy—A Chart Showing Sectional View of Single-Cylinder Gasoline Engine. Compiled by VICTOR W. PAGÉ, M.S.A.E.

This chart simplifies location of all power-plant troubles, and will prove invaluable to all who have to do with the operation, repair or sale of motorcycles. No details omitted. Size 25x38 inches. Price . . . . **25 cents**

Location of Ford Engine Troubles Made Easy. Compiled by VICTOR W. PAGÉ, M.S.A.E.

This shows clear sectional views depicting all portions of the Ford power plant and auxiliary groups. It outlines clearly all parts of the engine, fuel supply system, ignition group and cooling system, that are apt to give trouble, detailing all derangements that are liable to make an engine lose power, start hard or work irregularly. This chart is valuable to students, owners, and drivers, as it simplifies location of all engine faults. Of great advantage as an instructor for the novice, it can be used equally well by the more expert as a work of reference and review. It can be carried in the toolbox or pocket with ease and will save its cost in labor eliminated the first time engine trouble manifests itself. Prepared with special reference to the average man's needs and is a practical review of all motor troubles because it is based on the actual experience of an automobile engineer-mechanic with the mechanism the chart describes. It enables the non-technical owner or operator of a Ford car to locate engine derangements by systematic search, guided by easily recognized symptoms instead of by guesswork. It makes the average owner independent of the roadside repair shop when touring. Must be seen to be appreciated. Size 25x38 inches. Printed on heavy bond paper. Price . . . . **25 cents**

Modern Submarine Chart—with Two Hundred Parts Numbered and Named.

A cross-section view, showing clearly and distinctly all the interior of a Submarine of the latest type. You get more information from this chart, about the construction and operation of a Submarine, than in any other way. No details omitted—everything is accurate and to scale. It is absolutely correct in every detail, having been approved by Naval Engineers. All the machinery and devices fitted in a modern Submarine Boat are shown, and to make the engraving more readily understood all the features are shown in operative form, with Officers and Men in the act of performing the duties assigned to them in service conditions. This CHART IS REALLY AN ENCYCLOPEDIA OF A SUBMARINE. It is educational and worth many times its cost. Mailed in a Tube for . . . . . . **25 cents**

Box Car Chart.

A chart showing the anatomy of a box car, having every part of the car numbered and its proper name given in a reference list. Price . . . . **25 cents**

Gondola Car Chart.

A chart showing the anatomy of a gondola car, having every part of the car numbered and its proper reference name given in a reference list. Price . . . . **25 cents**

Passenger-Car Chart.

A chart showing the anatomy of a passenger-car, having every part of the car numbered and its proper name given in a reference list . . . . **25 cents**

Steel Hopper Bottom Coal Car.

A chart showing the anatomy of a steel Hopper Bottom Coal Car, having every part of the car numbered and its proper name given in a reference list. Price . . . . **25 cents**

Tractive Power Chart.

A chart whereby you can find the tractive power or drawbar pull of any locomotive without making a figure. Shows what cylinders are equal, how driving wheels and steam pressure affect the power. What sized engine you need to exert a given drawbar pull or anything you desire in this line. Price . . . . **50 cents**

Horse-Power Chart.

Shows the horse-power of any stationary engine without calculation. No matter what the cylinder diameter of stroke, the steam pressure of cut-off, the revolutions, or whether condensing or non-condensing, it's all there. Easy to use, accurate, and saves time and calculations. Especially useful to engineers and designers. Price . . . . **50 cents**

Boiler Room Chart. By Geo. L. Fowler.

A chart—size 14x28 inches—showing in isometric perspective the mechanisms belonging in a modern boiler room. The various parts are shown broken or removed, so that the internal construction is fully illustrated. Each part is given a reference number, and these, with the corresponding name, are given in a glossary printed at the sides. This chart is really a dictionary of the boiler room—the names of more than 200 parts being given. Price . **25 cents**

COKE

Modern Coking Practice, Including Analysis of Materials and Products. By J. E. Christopher and T. H. Byrom.

This, the standard work on the subject, has just been revised. It is a practical work for those engaged in Coke manufacture and the recovery of By-products. Fully illustrated with folding plates. It has been the aim of the authors, in preparing this book, to produce one which shall be of use and benefit to those who are associated with, or interested in, the modern developments of the industry. Among the Chapters contained in Volume I are: Introduction; Classification of Fuels; Impurities of Coals; Coal Washing; Sampling and Valuation of Coals, etc.; Power of Fuels; History of Coke Manufacture; Developments in the Coke Oven Design; Recent Types of Coke Ovens; Mechanical Appliances at Coke Ovens; Chemical and Physical Examination of Coke. Volume II covers fully the subject of By-Products.
Price, per volume . . . . **$3.00 net**

COMPRESSED AIR

Compressed Air in All Its Applications. By Gardner D. Hiscox.

This is the most complete book on the subject of Air that has ever been issued, and its thirty-five chapters include about every phase of the subject one can think of. It may be called an encyclopedia of compressed air. It is written by an expert, who, in its 665 pages, has dealt with the subject in a comprehensive manner, no phase of it being omitted. Includes the physical properties of air from a vacuum to its highest pressure, its thermodynamics, compression, transmission and uses as a motive power, in the Operation of Stationary and Portable Machinery, in Mining, Air Tools, Air Lifts, Pumping of Water, Acids, and Oils; the Air Blast for Cleaning and Painting the Sand Blast and its Work, and the Numerous Appliances in which Compressed Air is a Most Convenient and Economical Transmitter of Power for Mechanical Work, Railway Propulsion, Refrigeration, and the Various Uses to which Compressed Air has been applied. Includes forty-four tables of the physical properties of air, its compression, expansion, and volumes required for various kinds of work, and a list of patents on compressed air from 1875 to date. Over 500 illustrations, 5th Edition, revised and enlarged.

Cloth bound. Price **$5.00**

Half Morocco. Price **$6.50**

CONCRETE

Concrete Workers' Reference Books. A Series of Popular Handbooks for Concrete Users. Prepared by A. A. Houghton.

The author, in preparing this Series, has not only treated on the usual types of construction, but explains and illustrates molds and systems that are not patented, but which are equal in value and often superior to those restricted by patents. These molds are very easily and cheaply constructed and embody simplicity, rapidity of operation, and the most successful results in the molded concrete. Each of these books is fully illustrated, and the subjects are exhaustively treated in plain English.

Concrete Wall Forms. By A. A. Houghton.

A new automatic wall clamp is illustrated with working drawings. Other types of wall forms, clamps, separators, etc., are also illustrated and explained. (No. 1 of Series) Price **50 cents**

Concrete Floors and Sidewalks. By A. A. Houghton.

The molds for molding squares, hexagonal and many other styles of mosaic floor and sidewalk blocks are fully illustrated and explained. (No. 2 of Series) Price . . . . . . **50 cents**

Practical Concrete Silo Construction. By A. A. Houghton.

Complete working drawings and specifications are given for several styles of concrete silos, with illustrations of molds for monolithic and block silos. The tables, data, and information presented in this book are of the utmost value in planning and constructing all forms of concrete silos. (No. 3 of Series) Price . . . . **50 cents**

Molding Concrete Chimneys, Slate and Roof Tiles. By A. A. HOUGHTON.

The manufacture of all types of concrete slate and roof tile is fully treated. Valuable data on all forms of reinforced concrete roofs are contained within its pages. The construction of concrete chimneys by block and monolithic systems is fully illustrated and described. A number of ornamental designs of chimney construction with molds are shown in this valuable treatise. (No. 4 of Series.) Price . . . . **50 cents**

Molding and Curing Ornamental Concrete. By A. A. HOUGHTON.

The proper proportions of cement and aggregates for various finishes, also the method of thoroughly mixing and placing in the molds, are fully treated. An exhaustive treatise on this subject that every concrete worker will find of daily use and value. (No. 5 of Series.) Price . . . . **50 cents**

Concrete Monuments, Mausoleums and Burial Vaults. By A. A. HOUGHTON.

The molding of concrete monuments to imitate the most expensive cut stone is explained in this treatise, with working drawings of easily built molds. Cutting inscriptions and designs are also fully treated. (No. 6 of Series.) Price . . . . **50 cents**

Molding Concrete Bathtubs, Aquariums and Natatoriums. By A. A. HOUGHTON.

Simple molds and instruction are given for molding many styles of concrete bathtubs, swimming-pools, etc. These molds are easily built and permit rapid and successful work. (No. 7 of Series.) Price . . . . **50 cents**

Concrete Bridges, Culverts and Sewers. By A. A. HOUGHTON.

A number of ornamental concrete bridges with illustrations of molds are given. A collapsible center or core for bridges, culverts and sewers is fully illustrated with detailed instructions for building. (No. 8 of Series.) Price . . . . **50 cents**

Constructing Concrete Porches. By A. A. HOUGHTON.

A number of designs with working drawings of molds are fully explained so any one can easily construct different styles of ornamental concrete porches without the purchase of expensive molds. (No. 9 of Series.) Price . . . . **50 cents**

Molding Concrete Flower-Pots, Boxes, Jardinieres, Etc. By A. A. HOUGHTON.

The molds for producing many original designs of flower-pots, urns, flower-boxes, jardinieres, etc., are fully illustrated and explained, so the worker can easily construct and operate same. (No. 10 of Series.) Price . . . . **50 cents**

Molding Concrete Fountains and Lawn Ornaments. By A. A. HOUGHTON.

The molding of a number of designs of lawn seats, curbing, hitching posts, pergolas, sun dials and other forms of ornamental concrete for the ornamentation of lawns and gardens, is fully illustrated and described. (No. 11 of Series.) Price . . . . **50 cents**

Concrete from Sand Molds. By A. A. HOUGHTON.

A Practical Work treating on a process which has heretofore been held as a trade secret by the few who possessed it, and which will successfully mold every and any class of ornamental concrete work. The process of molding concrete with sand molds is of the utmost practical value, possessing the manifold advantages of a low cost of molds, the ease and rapidity of operation, perfect details to all ornamental designs, density and increased strength of the concrete, perfect curing of the work without attention and the easy removal of the molds regardless of any undercutting the design may have. 192 pages. Fully illustrated Price **$2.00**

Ornamental Concrete without Molds. By A. A. Houghton.

The process for making ornamental concrete without molds has long been held as a secret, and now, for the first time, this process is given to the public. The book reveals the secret and is the only book published which explains a simple, practical method whereby the concrete worker is enabled, by employing wood and metal templates of different designs, to mold or model in concrete any Cornice, Archivolt, Column, Pedestal, Base Cap, Urn or Pier in a monolithic form—right upon the job. These may be molded in units or blocks and then built up to suit the specifications demanded. This work is fully illustrated, with detailed engravings. Price **$2.00**

Concrete for the Farm and in the Shop. By H. Colin Campbell, C.E., E.M.

"Concrete for the Farm and in the Shop" is a new book from cover to cover, illustrating and describing in plain, simple language many of the numerous applications of concrete within the range of the home worker. Among the subjects treated are: Principles of Reinforcing; Methods of Protecting Concrete so as to Insure Proper Hardening; Home-made Mixers; Mixing by Hand and Machine; Form Construction, Described and Illustrated by Drawings and Photographs; Construction of Concrete Walls and Fences; Concrete Fence Posts; Concrete Gate Posts; Corner Posts; Clothes Line Posts; Grape Arbor Posts; Tanks; Troughs; Cisterns; Hog Wallows; Feeding Floors and Barnyard Pavements; Foundations; Well Curbs and Platforms; Indoor Floors; Sidewalks; Steps; Concrete Hotbeds and Cold Frames; Concrete Slab Roofs; Walls for Buildings; Repairing Leaks in Tanks and Cisterns; and all topics associated with these subjects as bearing upon securing the best results from concrete are dwelt upon at sufficient length in plain every-day English so that the inexperienced person desiring to undertake a piece of concrete construction can, by following the directions set forth in this book, secure 100 per cent. success every time. A number of convenient and practical tables for estimating quantities, and some practical examples, are also given. (5x7.) 149 pages. 51 illustrations. Price . . . . **75 cents**

Popular Handbook for Cement and Concrete Users. By Myron H. Lewis.

This is a concise treatise of the principles and methods employed in the manufacture and use of cement in all classes of modern works. The author has brought together in this work all the salient matter of interest to the user of concrete and its many diversified products. The matter is presented in logical and systematic order, clearly written, fully illustrated and free from involved mathematics. Everything of value to the concrete user is given, including kinds of cement employed in construction, concrete architecture, inspection and testing, waterproofing, coloring and painting, rules, tables, working and cost data. The book comprises thirty-three chapters, as follow: Introductory. Kinds of Cement and How They are Made. Properties. Testing and Requirements of Hydraulic Cement. Concrete and Its Properties. Sand, Broken Stone and Gravel for Concrete. How to Proportion the Materials. How to Mix and Place Concrete. Forms of Concrete Construction. The Architectural and Artistic Possibilities of Concrete. Concrete Residences. Mortars, Plasters and Stucco, and How to Use Them. The Artistic Treatment of Concrete Surfaces. Concrete Building Blocks. The Making of Ornamental Concrete. Concrete Pipes, Fences, Posts, etc. Essential Features and Advantages of Reenforced Concrete. How to Design Reenforced Concrete Beams, Slabs and Columns. Explanations of the Methods and Principles in Designing Reenforced Concrete, Beams and Slabs. Systems of Reenforcement Employed. Reenforced Concrete in Factory and General Building Construction. Concrete in Foundation Work. Concrete Retaining Walls, Abutments and Bulkheads. Concrete Arches and Arch Bridges. Concrete Beam and Girder Bridges. Concrete in Sewerage and Draining Works. Concrete Tanks, Dams and Reservoirs. Concrete Sidewalks, Curbs and Pavements. Concrete in Railroad Construction. The Utility of Concrete on the Farm. The Waterproofing of Concrete Structures. Grout of Liquid Concrete and Its Use. Inspection of Concrete Work. Cost of Concrete Work. Some of the special features of the book are: 1.—The Attention Paid to the Artistic and Architectural Side of Concrete Work. 2.—The Authoritative Treatment of the Problem of Waterproofing Concrete. 3.—An Excellent Summary of the Rules to be Followed in Concrete Construction. 4.—The Valuable Cost Data and Useful Tables given. A valuable Addition to the Library of Every Cement and Concrete User. Price . **$2.50**

Waterproofing Concrete. By Myron H. Lewis.

Modern Methods of Waterproofing Concrete and Other Structures. A condensed statement of the Principles, Rules, and Precautions to be Observed in Waterproofing and Dampproofing Structures and Structural Materials. Paper binding. Illustrated. Price . . . . **50 cents**

DICTIONARIES

Aviation Terms, Termes D'Aviation, English-French, French-English. Compiled by Lieuts. Victor W. Pagé, A.S., S.C.U.S.R., and Paul Montariol, of the French Flying Corps, on duty on Signal Corps Aviation School, Mineola, L. I.

The lists contained are confined to essentials, and special folding plates are included to show all important airplane parts. The lists are divided in four sections as follows: 1.—Flying Field Terms. 2.—The Airplane. 3.—The Engine. 4.—Tools and Shop Terms.
A complete, well illustrated volume intended to facilitate conversation between English-speaking and French aviators. A very valuable book for all who are about to leave for duty overseas.
Approved for publication by Major W. G. Kilner, S.C., U.S.C.O. Signal Corps Aviation School, Hazelhurst Field, Mineola, L. I. This book should be in every Aviator's and Mechanic's Kit for ready reference. 128 pages, fully illustrated, with detailed engravings. Price . . **$1.00**

Standard Electrical Dictionary. By T. O'Conor Sloane.

An indispensable work to all interested in electrical science. Suitable alike for the student and professional. A practical handbook of reference containing definitions of about 5,000 distinct words, terms and phrases. The definitions are terse and concise and include every term used in electrical science. Recently issued. An entirely new edition. Should be in the possession of all who desire to keep abreast with the progress of this branch of science. Complete, concise and convenient. 682 pages, 393 illustrations. Price **$3.00**

DIES—METAL WORK

Dies: Their Construction and Use for the Modern Working of Sheet Metals. By J. V. Woodworth.

A most useful book, and one which should be in the hands of all engaged in the press working of metals; treating on the Designing, Constructing, and Use of Tools, Fixtures and Devices, together with the manner in which they should be used in the Power Press, for the cheap and rapid production of the great variety of sheet-metal articles now in use. It is designed as a guide to the production of sheet-metal parts at the minimum of cost with the maximum of output. The hardening and tempering of Press tools and the classes of work which may be produced to the best advantage by the use of dies in the power press are fully treated. Its 515 illustrations show dies, press fixtures and sheet-metal working devices, the descriptions of which are so clear and practical that all metal-working mechanics will be able to understand how to design, construct and use them. Many of the dies and press fixtures treated were either constructed by the author or under his supervision. Others were built by skilful mechanics and are in use in large sheet-metal establishments and machine shops. 6th Revised and Enlarged Edition. Price **$3.00**

Punches, Dies and Tools for Manufacturing in Presses. By J. V. Woodworth.

This work is a companion volume to the author's elementary work entitled "Dies: Their Construction and Use." It does not go into the details of die-making to the extent of the author's previous book, but gives a comprehensive review of the field of operations carried on by presses. A large part of the information given has been drawn from the author's personal experience. It might well be termed an Encyclopedia of Die-Making, Punch-Making, Die-Sinking, Sheet-Metal Working, and Making of Special Tools, Sub-presses, Devices and Mechanical Combinations for Punching, Cutting, Bending, Forming, Piercing, Drawing, Compressing and Assembling Sheet-Metal Parts, and also Articles of other Materials in Machine Tools. 2d Edition. Price **$4.00**

Drop Forging, Die-Sinking and Machine-Forming of Steel. By J. V. Woodworth.

This is a practical treatise on Modern Shop Practice, Processes, Methods, Machine Tools, and Details treating on the Hot and Cold Machine-Forming of Steel and Iron into Finished Shapes; together with Tools, Dies, and Machinery involved in the manufacture of Duplicate Forgings and Interchangeable Hot and Cold Pressed Parts from Bar and Sheet Metal. This book fills a demand of long standing for information regarding drop-forgings, die-sinking and machine-forming of steel and the shop practice involved, as it actually exists in the modern drop-forging shop. The processes of die-sinking and force-making, which are thoroughly described and illustrated in this admirable work, are rarely to be found explained in such a clear and concise manner as is here set forth. The process of die-sinking relates to the engraving or sinking of the female or lower dies, such as are used for drop-forgings, hot and cold machine-forging, swedging, and the press working of metals. The process of force-making relates to the engraving or raising of the male or upper dies used in producing the lower dies for the press-forming and machine-forging of duplicate parts of metal.

In addition to the arts above mentioned the book contains explicit information regarding the drop-forging and hardening plants, designs, conditions, equipment, drop hammers, forging machines, etc., machine forging, hydraulic forging, autogenous welding and shop practice. The book contains eleven chapters, and the information contained in these chapters is just what will prove most valuable to the forged-metal worker. All operations described in the work are thoroughly illustrated by means of perspective half-tones and outline sketches of the machinery employed. 300 detailed illustrations. Price **$2.50**

DRAWING—SKETCHING PAPER

Practical Perspective. By Richards and Colvin.

Shows just how to make all kinds of mechanical drawings in the only practical perspective isometric. Makes everything plain, so that any mechanic can understand a sketch or drawing in this way. Saves time in the drawing room, and mistakes in the shops. Contains practical examples of various classes of work. 4th Edition. Price . . . . **50 cents**

Linear Perspective Self-Taught. By Herman T. C. Kraus.

This work gives the theory and practice of linear perspective, as used in architectural, engineering and mechanical drawings. Persons taking up the study of the subject by themselves will be able, by the use of the instruction given, to readily grasp the subject, and by reasonable practice become good perspective draftsmen. The arrangement of the book is good; the plate is on the left-hand, while the descriptive text follows on the opposite page, so as to be readily referred to. The drawings are on sufficiently large scale to show the work clearly and are plainly figured. There is included a self-explanatory chart which gives all information necessary for the thorough understanding of perspective. This chart alone is worth many times over the price of the book. 2d Revised and Enlarged Edition. Price **$2.50**

Self-Taught Mechanical Drawing and Elementary Machine Design. By F. L. Sylvester, M.E., Draftsman, with additions by Erik Oberg, associate editor of "Machinery."

This is a practical treatise on Mechanical Drawing and Machine Design, comprising the first principles of geometric and mechanical drawing, workshop mathematics, mechanics, strength of materials and the calculations and design of machine details. The author's aim has been to adapt this treatise to the requirements of the practical mechanic and young draftsman and to present the matter in as clear and concise a manner as possible. To meet the demands of this class of students, practically all the important elements of machine design have been dealt with, and in addition algebraic formulas have been explained, and the elements of trigonometry treated in the manner best suited to the needs of the practical man. The book isdivided into 20 chapters, and in arranging the material, mechanical drawing, pure and simple, has been taken up first, as a thorough understanding of the principles of representing objects facilitates the further study of mechanical subjects. This is followed by the mathematics necessary for the solution of the problems in machine design which are presented later, and a practical introduction to theoretical mechanics and the strength of materials. The various elements entering into machine design, such as cams, gears, sprocket-wheels, cone pulleys, bolts, screws, couplings, clutches, shafting and fly-wheels, have been treated in such a way as to make possible the use of the work as a text-book for a continuous course of study. It is easily comprehended and assimilated even by students of limited previous training. 330 pages, 215 engravings. Price **$2.00**

A New Sketching Paper.

A new specially ruled paper to enable you to make sketches or drawings in isometric perspective without any figuring or fussing. It is being used for shop details as well as for assembly drawings, as it makes one sketch do the work of three, and no workman can help seeing just what is wanted.

Pads of 40 sheets, 6x9 inches. Price . . . . **25 cents**

Pads of 40 sheets, 9x12 inches. Price . . . . **50 cents**

40 sheets, 12x18 inches. Price **$1.00**

ELECTRICITY

Arithmetic of Electricity. By Prof. T. O'Conor Sloane.

A practical treatise on electrical calculations of all kinds reduced to a series of rules, all of the simplest forms, and involving only ordinary arithmetic; each rule illustrated by one or more practical problems, with detailed solution of each one. This book is classed among the most useful works published on the science of electricity, covering as it does the mathematics of electricity in a manner that will attract the attention of those who are not familiar with algebraical formulas. 20th Edition. 160 pages. Price **$1.00**

Commutator Construction. By Wm. Baxter, Jr.

The business end of any dynamo or motor of the direct current type is the commutator. This book goes into the designing, building, and maintenance of commutators, shows how to locate troubles and how to remedy them; everyone who fusses with dynamos needs this. 4th Edition. Price . . . . **25 cents**

Dynamo Building for Amateurs, or How to Construct a Fifty-Watt Dynamo.
By Arthur J. Weed, Member of N. Y. Electrical Society.

A practical treatise showing in detail the construction of a small dynamo or motor, the entire machine work of which can be done on a small foot lathe. Dimensioned working drawings are given for each piece of machine work, and each operation is clearly described. This machine, when used as a dynamo, has an output of fifty watts; when used as a motor it will drive a small drill press or lathe. It can be used to drive a sewing machine on any and all ordinary work. The book is illustrated with more than sixty original engravings, showing the actual construction of the different parts. Among the contents are chapters on: 1. Fifty-Watt Dynamo. 2. Side Bearing Rods. 3. Field Punching. 4. Bearings. 5. Commutator. 6. Pulley. 7. Brush Holders. 8. Connection Board. 9. Armature Shaft. 10. Armature. 11. Armature Winding. 12. Field Winding. 13. Connecting and starting.

Paper. Price . . . . **50 cents**

Cloth. Price **$1.00**

Electric Bells. By M. B. Sleeper.

A complete treatise for the practical worker in Installing, Operating and Testing Bell Circuits, Burglar Alarms, Thermostats, and other apparatus used with Electric Bells.

Both the electrician and the experimenter will find in this book new material which is essential in their work. Tools, bells, batteries, unusual circuits, burglar alarms, annunciator systems, thermostats, circuit breakers, time alarms, and other apparatus used in bell circuits are described from the standpoints of their application, construction and repair. The detailed instruction for building the apparatus will appeal to the experimenter particularly.

The practical worker will find the chapter on Wiring, Calculation of Wire Sizes and Magnet Winding, Upkeep of Systems, and the Location of Faults, of the greatest value in their work. Among the chapters are: Tools and Materials for Bell Work; How and Why Bell Work; Batteries for Small Installations; Making Bells and Push Buttons; Wiring Bell Systems; Construction of Annunciators and Signals; Burglary Alarms and Auxiliary Apparatus; More Elaborate Bell Systems; Finding Faults and Remedying Them. 124 pages, fully illustrated. Price . . . . **50 cents**

Electric Lighting and Heating Pocket Book. By SYDNEY F. WALKER.

This book puts in convenient form useful information regarding the apparatus which is likely to be attached to the mains of an electrical company. Tables of units and equivalents are included and useful electrical laws and formulas are stated. 438 pages, 300 engravings. Bound in leather. Pocket book form. Price **$3.00**

Electric Wiring, Diagrams and Switchboards. By NEWTON HARRISON, with additions by THOMAS POPPE.

A thoroughly practical treatise covering the subject of Electric Wiring in all its branches, including explanations and diagrams which are thoroughly explicit and greatly simplify the subject. Practical, every-day problems in wiring are presented and the method of obtaining intelligent results clearly shown. Only arithmetic is used. Ohm's law is given a simple explanation with reference to wiring for direct and alternating currents. The fundamental principle of drop of potential in circuits is shown with its various applications. The simple circuit is developed with the position of mains, feeders and branches; their treatment as a part of a wiring plan and their employment in house wiring clearly illustrated. Some simple facts about testing are included in connection with the wiring. Molding and conduit work are given careful consideration; and switchboards are systematically treated, built up and illustrated, showing the purpose they serve, for connection with the circuits, and to shunt and compound wound machines. The simple principles of switchboard construction, the development of the switchboard, the connections of the various instruments, including the lightning arrester, are also plainly set forth.
Alternating current wiring is treated, with explanations of the power factor, conditions calling for various sizes of wire, and a simple way of obtaining the sizes for single-phase, two-phase and three-phase circuits. This is the only complete work issued showing and telling you what you should know about direct and alternating current wiring. It is a ready reference. The work is free from advanced technicalities and mathematics, arithmetic being used throughout. It is in every respect a handy, well-written, instructive, comprehensive volume on wiring for the wireman, foreman, contractor, or electrician. 2nd Revised Edition. 303 pages, 130 illustrations. Price **$1.50**

Electric Furnaces and their Industrial Applications. By J. WRIGHT.

This is a book which will prove of interest to many classes of people; the manufacturer who desires to know what product can be manufactured successfully in the electric furnace, the chemist who wishes to post himself on the electro-chemistry, and the student of science who merely looks into the subject from curiosity. New, Revised and Enlarged Edition. 320 pages. Fully illustrated, cloth. Price **$3.00**

Electric Toy Making, Dynamo Building, and Electric Motor Construction. By Prof. T. O'CONOR SLOANE.

This work treats of the making at home of electrical toys, electrical apparatus, motors, dynamos, and instruments in general, and is designed to bring within the reach of young and old the manufacture of genuine and useful electrical appliances. The work is especially designed for amateurs and young folks.
Thousands of our young people are daily experimenting, and busily engaged in making electrical toys and apparatus of various kinds. The present work is just what is wanted to give the much needed information in a plain, practical manner, with illustrations to make easy the carrying out of the work. 20th Edition. Price **$1.00**

Electricity Simplified. By Prof. T. O'CONOR SLOANE.

The object of "Electricity Simplified" is to make the subject as plain as possible and to show what the modern conception of electricity is; to show how two plates of different metal, immersed in acid, can send a message around the globe; to explain how a bundle of copper wire rotated by a steam engine can be the agent in lighting our streets, to tell what the volt, ohm and ampere are, and what high and low tension mean; and to answer the questions that perpetually arise in the mind in this age of electricity. 13th Edition. 172 pages. Illustrated. Price **$1.00**

House Wiring. By Thomas W. Poppe.

This work describes and illustrates the actual installation of Electric Light Wiring, the manner in which the work should be done, and the method of doing it. The book can be conveniently carried in the pocket. It is intended for the Electrician, Helper and Apprentice. It solves all Wiring Problems and contains nothing that conflicts with the rulings of the National Board of Fire Underwriters. It gives just the information essential to the Successful Wiring of a Building. Among the subjects treated are: Locating the Meter. Panel-Boards. Switches. Plug Receptacles. Brackets. Ceiling Fixtures. The Meter Connections. The Feed Wires. The Steel Armored Cable System. The Flexible Steel Conduit System. The Ridig Conduit System. A digest of the National Board of Fire Underwriters' rules relating to metallic wiring systems. Various switching arrangements explained and diagrammed. The easiest method of testing the Three- and Four-way circuits explained. The grounding of all metallic wiring systems and the reason for doing so shown and explained. The insulation of the metal parts of lamp fixtures and the reason for the same described and illustrated. 125 pages. 2nd Edition, revised and enlarged. Fully illustrated. Flexible cloth. Price . . . . **50 cents**

How to Become a Successful Electrician. By Prof. T. O'Conor Sloane.

Every young man who wishes to become a successful electrician should read this book. It tells in simple language the surest and easiest way to become a successful electrician. The studies to be followed, methods of work, field of operation and the requirements of the successful electrician are pointed out and fully explained. Every young engineer will find this an excellent stepping stone to more advanced works on electricity which he must master before success can be attained. Many young men become discouraged at the very outstart by attempting to read and study books that are far beyond their comprehension. This book serves as the connecting link between the rudiments taught in the public schools and the real study of electricity. It is interesting from cover to cover. 18th Revised Edition, just issued. 205 pages. Illustrated. Price **$1.00**

Management of Dynamos. By Lummis-Paterson.

A handbook of theory and practice. This work is arranged in three parts. The first part covers the elementarv theory of the dynamo. The second part, the construction and action of the different classes of dynamos in common use are described; while the third part relates to such matters as affect the practical management and working of dynamos and motors. 4th Edition. 292 pages, 117 illustrations. Price **$1.50**

Practical Electricity. By Prof. T. O'Conor Sloane.

This work of 768 pages was previously known as Sloane's Electricians' Hand Book, and is intended for the practical electrican who has to make things go. The entire field of electricity is covered within its pages. Among some of the subjects treated are: The Theory of the Electric Current and Circuit, Electro-Chemistry, Primary Batteries, Storage Batteries, Generation and Utilization of Electric Powers, Alternating Current, Armature Winding, Dynamos and Motors, Motor Generators, Operation of the Central Station Switchboards, Safety Appliances, Distribution of Electric Light and Power, Street Mains, Transformers, Arc and Incandescent Lighting, Electric Measurements, Photometry, Electric Railways, Telephony, Bell-Wiring, Electric-Plating, Electric Heating, Wireless Telegraphy, etc. It contains no useless theory; everything is to the point. It teaches you just what you want to know about electricity. It is the standard work published on the subject. Forty-one chapters, 556 engravings. Price **$2.50**

Switchboards. By William Baxter, Jr.

This book appeals to every engineer and electrician who wants to know the practical side of things. It takes up all sorts and conditions of dynamos, connections and circuits, and shows by diagram and illustration just how the switchboard should be connected. Includes direct and alternating current boards, also those for arc lighting, incandescent and power circuits. Special treatment on high voltage boards for power transmission. 2nd Edition. 190 pages, Illustrated. Price **$1.50**

Standard Electrical Dictionary. By T. O'CONOR SLOANE.

An indispensable work to all interested in electrical science. Suitable alike for the student and professional. A practical handbook of reference containing definitions of about 5,000 distinct words, terms and phrases. The definitions are terse and concise and include every term used in electrical science. Recently issued. An entirely new edition. Should be in the possession of all who desire to keep abreast with the progress of this branch of science. In its arrangement and typography the book is very convenient. The word or term defined is printed in black-faced type, which readily catches the eye, while the body of the page is in smaller but distinct type. The definitions are well worded, and so as to be understood by the non-technical reader. The general plan seems to be to give an exact, concise definition, and then amplify and explain in a more popular way. Synonyms are also given, and references to other words and phrases are made. A very complete and accurate index of fifty pages is at the end of the volume; and as this index contains all synonyms, and as all phrases are indexed in every reasonable combination of words, reference to the proper place in the body of the book is readily made. It is difficult to decide how far a book of this character is to keep the dictionary form, and to what extent it may assume the encyclopedia form. For some purposes, concise, exactly worded definitions are needed; for other purposes, more extended descriptions are required. This book seeks to satisfy both demands, and does it with considerable success. 682 pages, 393 illustrations. 12th Edition.
Price **$3.00**

Storage Batteries Simplified. By VICTOR W. PAGÉ, M.E.

A complete treatise on storage battery operating principles, repairs and applications. The greatly increasing application of storage batteries in modern engineering and mechanical work has created a demand for a book that will consider this subject completely and exclusively. This is the most thorough and authoritative treatise ever published on this subject. It is written in easily understandable, non-technical language so that any one may grasp the basic principles of storage battery action as well as their practical industrial applications. All electric and gasoline automobiles use storage batteries. Every automobile repairman, dealer or salesman should have a good knowledge of maintenance and repair of these important elements of the motor car mechanism. This book not only tells how to charge, care for and rebuild storage batteries but also outlines all the industrial uses. Learn how they run street cars, locomotives and factory trucks. Get an understanding of the important functions they perform in submarine boats, isolated lighting plants, railway switch and signal systems, marine applications, etc. This book tells how they are used in central station standby service, for starting automobile motors and in ignition systems. Every practical use of the modern storage battery is outlined in this treatise. 320 pages, fully illustrated. Price . . . **$1.50**

Telephone Construction, Installation, Wiring, Operation and Maintenance.
By W. H. RADCLIFFE and H. C. CUSHING.

This book is intended for the amateur, the wireman, or the engineer who desires to establish a means of telephonic communication between the rooms of his home, office, or shop. It deals only with such things as may be of use to him rather than with theories.
Gives the principles of construction and operation of both the Bell and Independent instruments; approved methods of installing and wiring them; the means of protecting them from lightning and abnormal currents; their connection together for operation as series or bridging stations; and rules for their inspection and maintenance. Line wiring and the wiring and operation of special telephone systems are also treated. Intricate mathematics are avoided, and all apparatus, circuits and systems are thoroughly described. The appendix contains definitions of units and terms used in the text. Selected wiring tables, which are very helpful, are also included. Among the subjects treated are Construction, Operation, and Installation of Telephone Instruments; Inspection and Maintenance of Telephone Instruments; Telephone Line Wiring; Testing Telephone Line Wires and Cables; Wiring and Operation of Special Telephone Systems, etc. 2nd Edition, Revised and Enlarged. 223 pages, 154 illustrations **$1.00**

Wiring a House. By HERBERT PRATT.

Shows a house already built; tells just how to start about wiring it; where to begin; what wire to use; how to run it according to Insurance Rules; in fact, just the information you need. Directions apply equally to a shop. 4th Edition. Price . . . . **25 cents**

Wireless Telegraphy and Telephony Simply Explained. By ALFRED P. MORGAN.

This is undoubtedly one of the most complete and comprehensible treatises on the subject ever published, and a close study of its pages will enable one to master all the details of the wireless transmission of messages. The author has filled a long-felt want and has succeeded in furnishing a lucid, comprehensible explanation in simple language of the theory and practice of wireless telegraphy and telephony.

Among the contents are: Introductory; Wireless Transmission and Reception—The Aerial System, Earth Connections—The Transmitting Apparatus, Spark Coils and Transformers, Condensers, Helixes, Spark Gaps, Anchor Gaps, Aerial Switches—The Receiving Apparatus, Detectors, etc.—Tuning and Coupling, Tuning Coils, Loose Couplers, Variable Condensers, Directive Wave Systems—Miscellaneous Apparatus, Telephone Receivers, Range of Stations Static Interference—Wireless Telephones, Sound and Sound Waves, The Vocal Cords and Ear—Wireless Telephone, How Sounds Are Changed into Electric Waves—Wireless Telephones, The Apparatus—Summary. 154 pages, 156 engravings. Price **$1.00**

FACTORY MANAGEMENT, ETC.

Modern Machine Shop Construction, Equipment and Management. By O. E. PERRIGO, M.E.

The only work published that describes the modern machine shop or manufacturing plant from the time the grass is growing on the site intended for it until the finished product is shipped. By a careful study of its thirty-two chapters the practical man may economically build, efficiently equip, and successfully manage the modern machine shop or manufacturing establishment. Just the book needed by those contemplating the erection of modern shop buildings, the rebuilding and reorganization of old ones, or the introduction of modern shop methods, time and cost systems. It is a book written and illustrated by a practical shop man for practical shop men who are too busy to read *theories* and want *facts*. It is the most complete all-around book of its kind ever published. It is a practical book for practical men, from the apprentice in the shop to the president in the office. It minutely describes and illustrates the most simple and yet the most efficient time and cost system yet devised. 2nd Revised and Enlarged Edition, just issued. 384 pages, 219 illustrations. Price . . . **$5.00**

FUEL

Combustion of Coal and the Prevention of Smoke. By WM. M. BARR.

This book has been prepared with special reference to the generation of heat by the combustion of the common fuels found in the United States, and deals particularly with the conditions necessary to the economic and smokeless combustion of bituminous coals in Stationary and Locomotive Steam Boilers.

The presentation of this important subject is systematic and progressive. The arrangement of the book is in a series of practical questions to which are appended accurate answers, which describe in language, free from technicalities, the several processes involved in the furnace combustion of American fuels; it clearly states the essential requisites for perfect combustion and points out the best methods for furnace construction for obtaining the greatest quantity of heat from any given quality of coal. Nearly 350 pages, fully illustrated. Price . . **$1.00**

Smoke Prevention and Fuel Economy. By BOOTH and KERSHAW.

A complete treatise for all interested in smoke prevention and combustion, being based on the German work of Ernst Schmatolla, but it is more than a mere translation of the German treatise, much being added. The authors show as briefly as possible the principles of fuel combustion, the methods which have been and are at present in use, as well as the proper scientific methods for obtaining all the energy in the coal and burning it without smoke. Considerable space is also given to the examination of the waste gases, and several of the representative English and American mechanical stoker and similar appliances are described. The losses carried away in the waste gases are thoroughly analyzed and discussed in the Appendix, and abstracts are also here given of various patents on combustion apparatus. The book is complete and contains much of value to all who have charge of large plants. 194 pages. Illustrated. Price **$2.50**

GAS ENGINES AND GAS

Gasoline and Oil Engines. By Gardner D. Hiscox. Revised by Victor W. Pagé, M.E.

Just issued New 1918 Edition, Revised and Enlarged. Every user of a gas engine needs this book. Simple, instructive and right up-to-date. The only complete work on the subject. Tells all about internal combustion engineering, treating exhaustively on the design, construction and practical application of all forms of gas, gasoline, kerosene and crude petroleum-oil engines. Describes minutely all auxiliary systems, such as lubrication, carburetion and ignition. Considers the theory and management of all forms of explosive motors for stationary and marine work, automobiles, aeroplanes and motor-cycles. Includes also Producer Gas and Its Production. Invaluable instructions for all students, gas-engine owners, gas-engineers, patent experts, designers, mechanics, draftsmen and all having to do with the modern power. Illustrated by over 400 engravings, many specially made from engineering drawings, all in correct proportion. 650 pages, 435 engravings. Price . . . . **$2.50 net**

Gasoline Engine on the Farm: Its Operation, Repair and Uses. By Xeno W. Putnam.

This is a practical treatise on the Gasoline and Kerosene Engine intended for the man who wants to know just how to manage his engine and how to apply it to all kinds of farm work to the best advantage.

This book abounds with hints and helps for the farm and suggestions for the home and housewife. There is so much of value in this book that it is impossible to adequately describe it in such small space. Suffice to say that it is the kind of a book every farmer will appreciate and every farm home ought to have. Includes selecting the most suitable engine for farm work, its most convenient and efficient installation, with chapters on troubles, their remedies, and how to avoid them. The care and management of the farm tractor in plowing, harrowing, harvesting and road grading are fully covered; also plain directions are given for handling the tractor on the road. Special attention is given to relieving farm life of its drudgery by applying power to the disagreeable small tasks which must otherwise be done by hand. Many home-made contrivances for cutting wood, supplying kitchen, garden, and barn with water, loading, hauling and unloading hay, delivering grain to the bins or the feed trough are included; also full directions for making the engine milk the cows, churn, wash, sweep the house and clean the windows, etc. Very fully illustrated with drawings of working parts and cuts showing Stationary, Portable and Tractor Engines doing all kinds of farm work. All money-making farms utilize power. Learn how to utilize power by reading the pages of this book. It is an aid to the result getter, invaluable to the up-to-date farmer, student, blacksmith, implement dealer and, in fact, all who can apply practical knowledge of stationary gasoline engines or gas tractors to advantage. 530 pages. Nearly 180 engravings. Price **$2.00**

WHAT IS SAID OF THIS BOOK:

"Am much pleased with the book and find it to be very complete and up-to-date. I will heartily recommend it to students and farmers whom I think would stand in need of such a work, as I think it is an exceptionally good one."—*N. S. Gardiner*, Prof. in Charge, Clemson Agr. College of S. C.; Dept. of Agri. and Agri. Exp. Station, Clemson College, S. C.

"I feel that Mr. Putnam's book covers the main points which a farmer should know."—*R. T. Burdick*, Instructor in Agronomy, University of Vermont, Burlington, Vt.

soline Engines: Their Operation, Use and Care. By A. Hyatt Verrill.

The simplest, latest and most comprehensive popular work published on Gasoline Engines, describing what the Gasoline Engine is; its construction and operation; how to install it; how to select it; how to use it and how to remedy troubles encountered. Intended for Owners, Operators and Users of Gasoline Motors of all kinds. This work fully describes and illustrates the various types of Gasoline Engines used in Motor Boats, Motor Vehicles and Stationary Work. The parts, accessories and appliances are described with chapters on ignition, fuel, lubrication, operation and engine troubles. Special attention is given to the care, operation and repair of motors, with useful hints and suggestions on emergency repairs and makeshifts. A complete glossary of technical terms and an alphabetically arranged table of troubles and their symptoms form most valuable and unique features of this manual. Nearly every illustration in the book is original, having been made by the author. Every page is full of interest and value. A book which you cannot afford to be without. 275 pages, 152 specially made engravings. Price **$1.50**

Gas Engine Construction, or How to Build a Half-horsepower Gas Engine. By PARSELL and WEED.

A practical treatise of 300 pages describing the theory and principles of the action of Gas Engines of various types and the design and construction of a half-horsepower Gas Engine, with illustrations of the work in actual progress, together with the dimensioned working drawings, giving clearly the sizes of the various details; for the student, the scientific investigator, and the amateur mechanic. This book treats of the subject more from the standpoint of practice than that of theory. The principles of operation of Gas Engines are clearly and simply described, and then the actual construction of a half-horsepower engine is taken up, step by step, showing in detail the making of the Gas Engine. 3rd Edition. 300 pages Price **$2.50**

How to Run and Install Two- and Four-Cycle Marine Gasoline Engines. By C. VON CULIN.

Revised and enlarged edition just issued. The object of this little book is to furnish a pocket instructor for the beginner, the busy man who uses an engine for pleasure or profit, but who does not have the time or inclination for a technical book, but simply to thoroughly understand how to properly operate, install and care for his own engine. The index refers to each trouble, remedy, and subject alphabetically. Being a quick reference to find the cause, remedy and prevention for troubles, and to become an expert with his own engine. Pocket size. Paper binding. Price . . . . **25 cents**

Modern Gas Engines and Producer Gas Plants. By R. E. MATHOT.

A guide for the gas engine designer, user, and engineer in the construction, selection, purchase, installation, operation, and maintenance of gas engines. More than one book on gas engines has been written, but not one has thus far even encroached on the field covered by this book. Above all, Mr. Mathot's work is a practical guide. Recognizing the need of a volume that would assist the gas engine user in understanding thoroughly the motor upon which he depends for power, the author has discussed his subject without the help of any mathematics and without elaborate theoretical explanations. Every part of the gas engine is described in detail, tersely, clearly, with a thorough understanding of the requirements of the mechanic. Helpful suggestions as to the purchase of an engine, its installation, care, and operation, form a most valuable feature of the work. 320 pages, 175 detailed illustrations. Price . . . **$2.50**

The Modern Gas Tractor. By VICTOR W. PAGÉ, M.E.

A complete treatise describing all types and sizes of gasoline, kerosene and oil tractors. Considers design and construction exhaustively, gives complete instructions for care, operation and repair, outlines all practical applications on the road and in the field. The best and latest work on farm tractors and tractor power plants. A work needed by farmers, students, blacksmiths, mechanics, salesmen, implement dealers, designers and engineers. 2nd Edition, Revised. 504 pages, 228 illustrations, 3 folding plates. Price **$2.00**

GEARING AND CAMS

Change Gear Devices. By OSCAR E. PERRIGO.

A practical book for every designer, draftsman, and mechanic interested in the invention and development of the devices for feed changes on the different machines requiring such mechanism. All the necessary information on this subject is taken up, analyzed, classified, sifted, and concentrated for the use of busy men who have not the time to go through the masses of irrelevant matter with which such a subject is usually encumbered and select such information as will be useful to them.

It shows just what has been done, how it has been done, when it was done, and who did it. It saves time in hunting up patent records and re-inventing old ideas. 88 pages. 3rd Edition. Price **$1.00**

Drafting of Cams. By LOUIS ROUILLION.

The laying out of cams is a serious problem unless you know how to go at it right. This puts you on the right road for practically any kind of cam you are likely to run up against. 3rd Edition. Price . . . . **25 cents**

Bevel Gear Tables. By D. AG. ENGSTROM.

A book that will at once commend itself to mechanics and draftsmen. Does away with all the trigonometry and fancy figuring on bevel gears, and makes it easy for anyone to lay them out or make them just right. There are 36 full-page tables that show every necessary dimension for all sizes or combinations you're apt to need. No puzzling, figuring or guessing. Gives placing distance, all the angles (including cutting angles), and the correct cutter to use. A copy of this prepares you for anything in the bevel-gear line. 3rd Edition. 66 pages. Price **$1.00**

HYDRAULICS

Hydraulic Engineering. By GARDNER D. HISCOX.

A treatise on the properties, power, and resources of water for all purposes. Including the measurement of streams, the flow of water in pipes or conduits; the horsepower of falling water, turbine and impact water-wheels, wave motors, centrifugal, reciprocating and air-lift pumps. With 300 figures and diagrams and 36 practical tables. All who are interested in water-works development will find this book a useful one, because it is an entirely practical treatise upon a subject of present importance and cannot fail in having a far-reaching influence, and for this reason should have a place in the working library of every engineer. Among the subjects treated are: Historical Hydraulics; Properties of Water; Measurement of the Flow of Streams; Flow from Sub-surface Orifices and Nozzles; Flow of Water in Pipes; Siphons of Various Kinds; Dams and Great Storage Reservoirs; City and Town Water Supply; Wells and Their Reinforcement; Air-lift Methods of Raising Water; Artesian Wells; Irrigation of Arid Districts; Water Power; Water Wheels; Pumps and Pumping Machinery; Reciprocating Pumps; Hydraulic Power Transmission; Hydraulic Mining; Canals; Ditches; Conduits and Pipe Lines; Marine Hydraulics; Tidal and Sea Wave Power, etc. 320 pages. Price . . . **$4.00**

ICE AND REFRIGERATION

Pocketbook of Refrigeration and Ice Making. By A. J. WALLIS-TAYLOR.

This is one of the latest and most comprehensive reference books published on the subject of refrigeration and cold storage. It explains the properties and refrigerating effect of the different fluids in use, the management of refrigerating machinery and the construction and insulation of cold rooms with their required pipe surface for different degrees of cold; freezing mixtures and non-freezing brines, temperatures of cold rooms for all kinds of provisions, cold storage charges for all classes of goods, ice making and storage of ice, data and memoranda for constant reference by refrigerating engineers, with nearly one hundred tables containing valuable references to every fact and condition required in the installment and operation of a refrigerating plant. New edition just published. Price **$1.50**

INVENTIONS—PATENTS

Inventors' Manual: How to Make a Patent Pay.

This is a book designed as a guide to inventors in perfecting their inventions, taking out their patents and disposing of them. It is not in any sense a Patent Solicitor's Circular nor a Patent Broker's Advertisement. No advertisements of any description appear in the work. It is a book containing a quarter of a century's experience of a successful inventor, together with notes based upon the experience of many other inventors.

Among the subjects treated in this work are: How to Invent. How to Secure a Good Patent. Value of Good Invention. How to Exhibit an Invention. How to Interest Capital. How to Estimate the Value of a Patent. Value of Design Patents. Value of Foreign Patents. Value of Small Inventions. Advice on Selling Patents. Advice on the Formation of Stock Companies. Advice on the Formation of Limited Liability Companies. Advice on Disposing of Old Patents. Advice as to Patent Attorneys. Advice as to Selling Agents. Forms of Assignments. License and Contracts. State Laws Concerning Patent Rights. 1900 Census of the United States by Counts of Over 10,000 Population. Revised Edition. 120 pages. Price **$1.00**

KNOTS

Knots, Splices and Rope Work. By A. Hyatt Verrill.

This is a practical book giving complete and simple directions for making all the most useful and ornamental knots in common use, with chapters on Splicing, Pointing, Seizing, Serving, etc. This book is fully illustrated with 154 original engravings, which show how each knot, tie or splice is formed, and its appearance when finished. The book will be found of the greatest value to Campers, Yachtsmen, Travelers, Boy Scouts, in fact, to anyone having occasion to use or handle rope or knots for any purpose. The book is thoroughly reliable and practical, and is not only a guide, but a teacher. It is the standard work on the subject. Among the contents are: 1. Cordage, Kinds of Rope. Construction of Rope, Parts of Rope Cable and Bolt Rope. Strength of Rope, Weight of Rope. 2. Simple Knots and Bends. Terms Used in Handling Rope. Seizing Rope. 3. Ties and Hitches. 4. Noose, Loops and Mooring Knots. 5. Shortenings, Grommets and Salvages. 6. Lashings, Seizings and Splices. 7. Fancy Knots and Rope Work. 128 pages, 150 original engravings. 2nd Revised Edition. Price . . . . **75 cents**

LATHE WORK

Lathe Design, Construction, and Operation, with Practical Examples of Lathe Work. By Oscar E. Perrigo.

A new, revised edition, and the only complete American work on the subject, written by a man who knows not only how work ought to be done, but who also knows how to do it, and how to convey this knowledge to others. It is strictly up-to-date in its descriptions and illustrations. Lathe history and the relations of the lathe to manufacturing are given; also a description of the various devices for feeds and thread-cutting mechanisms from early efforts in this direction to the present time. Lathe design is thoroughly discussed, including back gearing, driving cones, thread-cutting gears, and all the essential elements of the modern lathe. The classification of lathes is taken up, giving the essential differences of the several types of lathes including, as is usually understood, engine lathes, bench lathes, speed lathes, forge lathes, gap lathes, pulley lathes, forming lathes, multiple-spindle lathes, rapid-reduction lathes, precision lathes, turret lathes, special lathes, electrically driven lathes, etc. In addition to the complete exposition on construction and design, much practical matter on lathe installation, care and operation has been incorporated in the enlarged new edition. All kinds of lathe attachments for drilling, milling, etc., are described and complete instructions are given to enable the novice machinist to grasp the art of lathe operation as well as the principles involved in design. A number of difficult machining operations are described at length and illustrated. The new edition has nearly 500 pages and 350 illustrations. Price **$2.50**

WHAT IS SAID OF THIS BOOK:

"This is a lathe book from beginning to end, and is just the kind of a book which one delights to consult—a masterly treatment of the subject in hand."—*Engineering News.*

"This work will be of exceptional interest to any one who is interested in lathe practice, as one very seldom sees such a complete treatise on a subject as this is on the lathe."—*Canadian Machinery.*

Practical Metal Turning. By Joseph G. Horner.

A work of 404 pages, fully illustrated, covering in a comprehensive manner the modern practice of machining metal parts in the lathe, including the regular engine lathe, its essential design, its uses, its tools, its attachments, and the manner of holding the work and performing the operations. The modernized engine lathe, its methods, tools and great range of accurate work. The turret lathe, its tools, accessories and methods of performing its functions. Chapters on special work, grinding, tool holders, speeds, feeds, modern tool steels, etc. Second edition **$3.50**

Turning and Boring Tapers. By Fred H. Colvin.

There are two ways to turn tapers; the right way and one other. This treatise has to do with the right way; it tells you how to start the work properly, how to set the lathe, what tools to use and how to use them, and forty and one other little things that you should know. Fourth edition . . . . **25 cents**

LIQUID AIR

Liquid Air and the Liquefaction of Gases. By T. O'CONOR SLOANE.

This book gives the history of the theory, discovery and manufacture of Liquid Air, and contains an illustrated description of all the experiments that have excited the wonder of audiences all over the country. It shows how liquid air, like water, is carried hundreds of miles and is handled in open buckets. It tells what may be expected from it in the near future.

A book that renders simple one of the most perplexing chemical problems of the century. Startling developments illustrated by actual experiments.

It is not only a work of scientific interest and authority, but is intended for the general reader, being written in a popular style—easily understood by every one. Second edition. 365 pages. Price **$2.00**

LOCOMOTIVE ENGINEERING

Air-Brake Catechism. By ROBERT H. BLACKALL.

This book is a standard text-book. It covers the Westinghouse Air-Brake Equipment, including the No. 5 and the No. 6 E.-T. Locomotive Brake Equipment; the K (Quick Service) Triple Valve for Freight Service; and the Cross-Compound Pump. The operation of all parts of the apparatus is explained in detail, and a practical way of finding their peculiarities and defects, with a proper remedy, is given. It contains 2,000 questions with their answers, which will enable any railroad man to pass any examination on the subject of Air Brakes. Endorsed and used by air-brake instructors and examiners on nearly every railroad in the United States. Twenty-sixth edition. 411 pages, fully illustrated with colored plates and diagrams. Price **$2.00**

American Compound Locomotives. By FRED H. COLVIN.

The only book on compounds for the engineman or shopman that shows in a plain, practical way the various features of compound locomotives in use. Shows how they are made, what to do when they break down or balk. Contains sections as follows: A Bit of History. Theory of Compounding Steam Cylinders. Baldwin Two-Cylinder Compound. Pittsburg Two-Cylinder Compound. Rhose Island Compound. Richmond Compound. Rogers Compound. Schenectady Two-Cylinder Compound. Vauclain Compound. Tandem Compounds. Baldwin Tandem. The Colvin-Wightman Tandem. Schenectady Tandem. Balanced Locomotives. Baldwin Balanced Compound. Plans for Balancing. Locating Blows. Breakdowns. Reducing Valves. Drifting. Valve Motion. Disconnecting. Power of Compound Locomotives. Practical Notes.

Fully illustrated and containing ten special "Duotone" inserts on heavy Plate Paper, showing different types of Compounds. 142 pages. Price **$1.00**

Application of Highly Superheated Steam to Locomotives. By ROBERT GARBE.

A practical book which cannot be recommended too highly to those motive-power men who are anxious to maintain the highest efficiency in their locomotives. Contains special chapters on Generation of Highly Superheated Steam; Superheated Steam and the Two-Cylinder Simple Engine; Compounding and Superheating; Designs of Locomotive Superheaters; Constructive Details of Locomotives Using Highly Superheated Steam. Experimental and Working Results. Illustrated with folding plates and tables. Cloth. Price **$2.50**

Combustion of Coal and the Prevention of Smoke. By WM. M. BARR.

This book has been prepared with special reference to the generation of heat by the combustion of the common fuels found in the United States and deals particularly with the conditions necessary to the economic and smokeless combustion of bituminous coal in Stationary and Locomotive Steam Boilers.

Presentation of this important subject is systematic and progressive. The arrangement of the book is in a series of practical questions to which are appended accurate answers, which describe in language free from technicalities the several processes involved in the furnace combustion of American fuels; it clearly states the essential requisites for perfect combustion, and points out the best methods of furnace construction for obtaining the greatest quantity of heat from any given quality of coal. Nearly 350 pages, fully illustrated. Price **$1.00**

Diary of a Round-House Foreman. By T. S. Reilly.

This is the greatest book of railroad experiences ever published. Containing a fund of information and suggestions along the line of handling men, organizing, etc., that one cannot afford to miss. 176 pages. Price **$1.00**

Link Motions, Valves and Valve Setting. By Fred H. Colvin, Associate Editor of "American Machinist."

A handy book for the engineer or machinist that clears up the mysteries of valve setting. Shows the different valve gears in use, how they work, and why. Piston and slide valves of different types are illustrated and explained. A book that every railroad man in the motive-power department ought to have. Contains chapters on Locomotive Link Motion, Valve Movements, Setting Slide Valves, Analysis by Diagrams, Modern Practice, Slip of Block, Slice Valves, Piston Valves, Setting Piston Valves, Joy-Allen Valve Gear, Walschaert Valve Gear, Gooch Valve Gear, Alfree-Hubbell Valve Gear, etc., etc. Fully illustrated. Price . . . . **50 cents**

Locomotive Boiler Construction. By Frank A. Kleinhans.

The construction of boilers in general is treated and, following this, the locomotive boiler is taken up in the order in which its various parts go through the shop. Shows all types of boilers used; gives details of construction; practical facts, such as life of riveting, punches and dies; work done per day, allowance for bending and flanging sheets and other data. Including the recent Locomotive Boiler Inspection Laws and Examination Questions with their answers for Government Inspectors. Contains chapters on Laying-Out Work; Flanging and Forging; Punching; Shearing; Plate Planing; General Tables; Finishing Parts; Bending; Machinery Parts; Riveting; Boiler Details; Smoke-Box Details; Assembling and Calking; Boiler-Shop Machinery, etc., etc.

There isn't a man who has anything to do with boiler work, either new or repair work, who doesn't need this book. The manufacturer, superintendent, foreman and boiler worker—all need it. No matter what the type of bioler, you'll find a mint of information that you wouldn't be without. Over 400 pages, five large folding plates. Price **$3.00**

Locomotive Breakdowns and their Remedies. By Geo. L. Fowler. Revised by Wm. W. Wood, Air-Brake Instructor. Just issued. Revised pocket edition.

It is out of the question to try and tell you about every subject that is covered in this pocket edition of Locomotive Breakdowns. Just imagine all the common troubles that an engineer may expect to happen some time, and then add all of the unexpected ones, troubles that could occur, but that you have never thought about, and you will find that they are all treated with the very best methods of repair. Walschaert Locomotive Valve Gear Troubles, Electric Headlight Troubles, as well as Questions and Answers on the Air Brake are all included. 312 pages. 8th Revised Edition. Fully illustrated. Price **$1.00**

Locomotive Catechism. By Robert Grimshaw.

The revised edition of "Locomotive Catechism," by Robert Grimshaw, is a New Book from Cover to Cover. It contains twice as many pages and double the number of illustrations of previous editions. Includes the greatest amount of practical information ever published on the construction and management of modern locomotives. Specially Prepared Chapters on the Walschaert Locomotive Valve Gear, the Air-Brake Equipment and the Electric Headlight are given.

It commends itself at once to every Engineer and Fireman, and to all who are going in for examination or promotion. In plain language, with full, complete answers, not only all the questions asked by the examining engineer are given, but those which the young and less experienced would ask the veteran, and which old hands ask as "stickers." It is a veritable Encyclopedia of the Locomotive, is entirely free from mathematics, easily understood and thoroughly up to date. Contains over 4,000 Examination Questions with their Answers. 825 pages, 437 illustrations, and 3 folding plates. 28th Revised Edition. Price . . . **$2.50**

Practical Instructor and Reference Book for Locomotive Firemen and Engineers. By CHAS. F. LOCKHART.

An entirely new book on the Locomotive. It appeals to every railroad man, as it tells him how things are done and the right way to do them. Written by a man who has had years of practical experience in locomotive shops and on the road firing and running. The information given in this book cannot be found in any other similar treatise. Eight hundred and fifty-one questions with their answers are included, which will prove specially helpful to those preparing for examination. Practical information on: The Construction and Operation of Locomotives, Breakdowns and their Remedies, Air Brakes and Valve Gears. Rules and Signals are handled in a thorough manner. As a book of reference it cannot be excelled. The book is divided into six parts, as follows: 1. The Fireman's Duties. 2. General Description of the Locomotive. 3. Breakdowns and their Remedies. 4. Air Brakes. 5. Extracts from Standard Rules. 6. Questions for Examination. The 851 questions have been carefully selected and arranged. These cover the examinations required by the different railroads. 368 pages, 88 illustrations. Price **$1.50**

Prevention of Railroad Accidents, or Safety in Railroading. By GEORGE BRADSHAW.

This book is a heart-to-heart talk with Railroad Employees, dealing with facts, not theories, and showing the men in the ranks, from every-day experience, how accidents occur and how they may be avoided. The book is illustrated with seventy original photographs and drawings showing the safe and unsafe methods of work. No visionary schemes, no ideal pictures. Just Plain Facts and Practical Suggestions are given. Every railroad employee who reads the book is a better and safer man to have in railroad service. It gives just the information which will be the means of preventing many injuries and deaths. All railroad employees should procure a copy, read it, and do their part in preventing accidents. 169 pages. Pocket size. Fully illustrated. Price........ **50 cents**

Train Rule Examinations Made Easy. By G. E. COLLINGWOOD.

This is the only practical work on train rules in print. Every detail is covered, and puzzling points are explained in simple, comprehensive language, making it a practical treatise for the Train Dispatcher, Engineman, Trainman, and all others who have to do with the movements of trains. Contains complete and reliable information of the Standard Code of Train Rules for single track. Shows Signals in Colors, as used on the different roads. Explains fully the practical application of train orders, giving a clear and definite understanding of all orders which may be used. The meaning and necessity for certain rules are explained in such a manner that the student may know beyond a doubt the rights conferred under any orders he may receive or the action required by certain rules. As nearly all roads require trainmen to pass regular examinations, a complete set of examination questions, with their answers, are included. These will enable the student to pass the required examinations with credit to himself and the road for which he works. 2nd Edition, Revised. 256 pages, fully illustrated, with Train Signals in Colors. Price........ **$1.25**

The Walschaert and Other Modern Radial Valve Gears for Locomotives. By WM. W. WOOD.

If you would thoroughly understand the Walschaert Valve Gear you should possess a copy of this book, as the author takes the plainest form of a steam engine—a stationary engine in the rough, that will only turn its crank in one direction—and from it builds up, with the reader's help, a modern locomotive equipped with the Walschaert Valve Gear, complete. The points discussed are clearly illustrated: Two large folding plates that show the positions of the valves of both inside or outside admission type, as well as the links and other parts of the gear when the crank is at nine different points in its revolution, are especially valuable in making the movement clear. These employ sliding cardboard models which are contained in a pocket in the cover.

The book is divided into five general divisions, as follows: 1. Analysis of the gear. 2. Designing and erecting the gear. 3. Advantages of the gear. 4. Questions and answers relating to the Walschaert Valve Gear. 5. Setting valves with the Walschaert Valve Gear; the three primary types of locomotive valve motion; modern radial valve gears other than the Walschaert; the Hobart All-free Valve and Valve Gear, with questions and answers on breakdowns; the Baker-Pilliod Valve Gear; the Improved Baker-Pilliod Valve Gear, with questions and answers on breakdowns.

The questions with full answers given will be especially valuable to firemen and engineers in preparing for an examination for promotion. 245 pages. 3rd Revised Edition. Price **$1.50**

Westinghouse E-T Air-Brake Instruction Pocket Book. By WM. W. WOOD, Air-Brake Instructor.

Here is a book for the railroad man, and the man who aims to be one. It is without doubt the only complete work published on the Westinghouse E-T Locomotive Brake Equipment. Written by an Air-Brake Instructor who knows just what is needed. It covers the subject thoroughly. Everything about the New Westinghouse Engine and Tender Brake Equipment, including the standard No. 5 and the Perfected No. 6 style of brake, is treated in detail. Written in plain English and profusely illustrated with Colored Plates, which enable one to trace the flow of pressures throughout the entire equipment. The best book ever published on the Air Brake. Equally good for the beginner and the advanced engineer. Will pass any one through any examination. It informs and enlightens you on every point. Indispensable to every engineman and trainman.
Contains examination questions and answers on the E-T equipment. Covering what the E-T Brake is. How it should be operated. What to do when defective. Not a question can be asked of the engineman up for promotion, on either the No. 5 or the No. 6 E-T equipment, that is not asked and answered in the book. If you want to thoroughly understand the E-T equipment get a copy of this book. It covers every detail. Makes Air-Brake troubles and examinations easy. Price.. **$1.50**

MACHINE-SHOP PRACTICE

American Tool Making and Interchangeable Manufacturing. By J. V. WOODWORTH.

A "shoppy" book, containing no theorizing, no problematical or experimental devices. There are no badly proportioned and impossible diagrams, no catalogue cuts, but a valuable collection of drawings and descriptions of devices, the rich fruits of the author's own experience. In its 500-odd pages the one subject only, Tool Making, and whatever relates thereto, is dealt with. The work stands without a rival. It is a complete, practical treatise, on the art of American Tool Making and system of interchangeable manufacturing as carried on to-day in the United States. In it are described and illustrated all of the different types and classes of small tools, fixtures, devices, and special appliances which are in general use in all machine-manufacturing and metal-working establishments where economy, capacity, and interchangeability in the production of machined metal parts are imperative. The science of jig making is exhaustively discussed, and particular attention is paid to drill jigs, boring, profiling and milling fixtures and other devices in which the parts to be machined are located and fastened within the contrivances. All of the tools, fixtures, and devices illustrated and described have been or are used for the actual production of work, such as parts of drill presses, lathes, patented machinery, typewriters, electrical apparatus, mechanical appliances, brass goods, composition parts, mould products, sheet-metal articles, drop-forgings, jewelry, watches, medals, coins, etc. 531 pages. Price.. **$4.00**

HENLEY'S ENCYCLOPEDIA OF PRACTICAL ENGINEERING AND ALLIED TRADES. EDITED by JOSEPH G. HORNER, A.M.I., M.E.

This set of five volumes contains about 2,500 pages with thousands of illustrations, including diagrammatic and sectional drawings with full explanatory details. This work covers the entire practice of Civil and Mechanical Engineering. The best known experts in all branches of engineering have contributed to these volumes. The Cyclopedia is admirably well adapted to the needs of the beginner and the self-taught practical man, as well as the mechanical engineer, designer, draftsman, shop superintendent, foreman, and machinist. The work will be found a means of advancement to any progressive man. It is encyclopedic in scope, thorough and practical in its treatment on technical subjects, simple and clear in its descriptive matter, and without unnecessary technicalities or formulæ. The articles are as brief as may be and yet give a reasonably clear and explicit statement of the subject, and are written by men who have had ample practical experience in the matters of which they write. It tells you all you want to know about engineering and tells it so simply, so clearly, so concisely, that one cannot help but understand. As a work of reference it is without a peer. Complete set of five volumes, price **$25.00**

Threads and Thread Cutting. By COLVIN and STABEL.

This clears up many of the mysteries of thread-cutting, such as double and triple threads, internal threads, catching threads, use of hobs, etc. Contains a lot of useful hints and several tables. Third edition. Price.. **25 cents**

THE WHOLE FIELD OF MECHANICAL MOVEMENTS COVERED BY MR. HISCOX'S TWO BOOKS

We publish two books by Gardner D. Hiscox that will keep you from "inventing" things that have been done before, and suggest ways of doing things that you have not thought of before. Many a man spends time and money pondering over some mechanical problem, only to learn, after he has solved the problem, that the same thing has been accomplished and put in practice by others long before. Time and money spent in an effort to accomplish what has already been accomplished are time and money LOST. The whole field of mechanics, every known mechanical movement, and practically every device are covered by these two books. If the thing you want has been invented, it is illustrated in them. If it hasn't been invented, then you'll find in them the nearest things to what you want, some movements or devices that will apply in your case, perhaps; or which will give you a key from which to work. No book or set of books ever published is of more real value to the Inventor, Draftsman, or practical Mechanic than the two volumes described below.

Mechanical Movements, Powers, and Devices. By GARDNER D. HISCOX.

This is a collection of 1,890 engravings of different mechanical motions and appliances, accompanied by appropriate text, making it a book of great value to the inventor, the draftsman, and to all readers with mechanical tastes. The book is divided into eighteen sections or chapters, in which the subject-matter is classified under the following heads: Mechanical Powers; Transmission of Power; Measurement of Power; Steam Power; Air Power Appliances; Electric Power and Construction; Navigation and Roads; Gearing; Motion and Devices; Controlling Motion; Horological; Mining; Mill and Factory Appliances; Construction and Devices; Drafting Devices; Miscellaneous Devices, etc. 15th Edition. 400 octavo pages. Price **$3.00**

Mechanical Appliances, Mechanical Movements and Novelties of Construction. By GARDNER D. HISCOX.

This is a supplementary volume to the one upon mechanical movements. Unlike the first volume, which is more elementary in character, this volume contains illustrations and descriptions of many combinations of motions and of mechanical devices and appliances found in different lines of machinery, each device being shown by a line drawing with a description showing its working parts and the method of operation. From the multitude of devices described and illustrated might be mentioned, in passing, such items as conveyors and elevators, Pony brakes, thermometers, various types of boilers, solar engines, oil-fuel burners, condensers, evaporators, Corliss and other valve gears, governors, gas engines, water motors of various descriptions, air ships, motors and dynamos, automobile and motor bicycles, railway lock signals, car couplers, link and gear motions, ball bearings, breech-block mechanism for heavy guns, and a large accumulation of others of equal importance. One thousand specially made engravings. 396 octavo pages. Fourth edition. Price.......................... **$3.00**

Machine-Shop Tools and Shop Practice. By W. H. VANDERVOORT.

A work of 555 pages and 673 illustrations, describing in every detail the construction, operation and manipulation of both hand and machine tools. Includes chapters on filing, fitting and scraping surfaces; on drills, reamers, taps and dies; the lathe and its tools: planers, shapers, and their tools; milling machines and cutters; gear cutters and gear cutting; drilling machines and drill work; grinding machines and their work; hardening and tempering; gearing, belting and transmission machinery; useful data and tables. Sixth edition. Price.. **$3.00**

Machine-Shop Arithmetic. By COLVIN-CHENEY.

This is an arithmetic of the things you have to do with daily. It tells you plainly about: how to find areas in figures; how to find surface or volume of balls or spheres; handy ways for calculating; about compound gearing; cutting screw threads on any lathe; drilling for taps; speeds of drills; taps, emery wheels, grindstones, milling cutters, etc.; all about the Metric system with conversion tables; properties of metals; strength of bolts and nuts; decimal equivalent of an inch. All sorts of machine-shop figuring and 1,001 other things, any one of which ought to be worth more than the price of this book to you, as it saves you the trouble of bothering the boss. 6th Edition. 131 pages. Price . . . . **50 cents**

Modern Milling Machines: Their Design, Construction, and Operation. By JOSEPH G. HORNER.

This book describes and illustrates the Milling Machine and its work in such a plain, clear and forceful manner, and illustrates the subject so clearly and completely, that the up-to-date machinist, student or mechanical engineer cannot afford to do without the valuable information which it contains. It describes not only the early machines of this class, but notes their gradual development into the splendid machines of the present day, giving the design and construction of the various types, forms, and special features produced by prominent manufacturers, American and foreign. 304 pages, 300 illustrations. Cloth. Price... **$4.00**

"Shop Kinks." By ROBERT GRIMSHAW.

A book of 400 pages and 222 illustrations, being entirely different from any other book on machine-shop practice. Departing from conventional style, the author avoids universal or common shop usage and limits his work to showing special ways of doing things better, more cheaply and more rapidly than usual. As a result the advanced methods of representative establishments of the world are placed at the disposal of the reader. This book shows the proprietor where large savings are possible, and how products may be improved. To the employee it holds out suggestions that, properly applied, will hasten his advancement. No shop can afford to be without it. It bristles with valuable wrinkles and helpful suggestions. It will benefit all, from apprentice to proprietor. Every machinist, at any age, should study its pages. Fifth edition. Price.. **$2.50**

The Modern Machinist. By JOHN T. USHER.

This is a book, showing by plain description and by profuse engravings made expressly for the work, all that is best, most advanced, and of the highest efficiency in modern machine-shop practice, tools and implements, showing the way by which and through which, as Mr. Maxim says, "American machinists have become and are the finest mechanics in the world." Indicating as it does, in every line, the familiarity of the author with every detail of daily experience in the shop, it cannot fail to be of service to any man practically connected with the shaping or finishing of metals.

There is nothing experimental or visionary about the book, all devices being in actual use and giving good results. It might be called a compendium of shop methods, showing a variety of special tools and appliances which will give new ideas to many mechanics, from the superintendent down to the man at the bench. It will be found a valuable addition to any machinist's library, and should be consulted whenever a new or difficult job is to be done, whether it is boring, milling, turning, or planing, as they are all treated in a practical manner. Fifth edition. 320 pages. 250 illustrations. Price..................... **$2.50**

Modern Machine-Shop Construction, Equipment and Management. By OSCAR E. PERRIGO.

The only work published that describes the Modern Shop or Manufacturing Plant from the time the grass is growing on the site intended for it until the finished product is shipped. Just the book needed by those contemplating the erection of modern shop buildings, the rebuilding and reorganization of old ones, or the introduction of Modern Shop Methods, time and cost systems. It is a book written and illustrated by a practical shop man for practical shop men who are too busy to read theories and want facts. It is the most complete all-round book of its kind ever published. Second Edition, Revised. 384 large quarto pages. 219 original and specially made illustrations. 2nd Revised and Enlarged Edition. Price **$5.00**

MANUAL TRAINING

Economics of Manual Training. By LOUIS ROUILLION.

The only book published that gives just the information needed by all interested in Manual Training, regarding Buildings, Equipment, and Supplies. Shows exactly what is needed for all grades of the work from the Kindergarten to the High and Normal School. Gives itemized lists of everything used in Manual Training Work and tells just what it ought to cost. Also shows where to buy supplies, etc. Contains 174 pages, and is fully illustrated. Second edition. Price.. **$1.50**

MARINE ENGINEERING

The Naval Architect's and Shipbuilder's Pocket Book of Formulæ, Rules, and Tables and Marine Engineer's and Surveyor's Handy Book of Reference. By CLEMENT MACKROW and LLOYD WOOLLARD.

The eleventh Revised and Enlarged Edition of this most comprehensive work has just been issued. It is absolutely indispensable to all engaged in the Shipbuilding Industry, as it condenses into a compact form all data and formulæ that are ordinarily required. The book is completely up to date, including among other subjects a section on Aeronautics. 750 pages, limp leather binding. Price .... **$5.00 net**

Marine Engines and Boilers: Their Design and Construction. By DR. G. BAUER, LESLIE S. ROBERTSON and S. BRYAN DONKIN.

In the words of Dr. Bauer, the present work owes its origin to an oft felt want of a condensed treatise embodying the theoretical and practical rules used in designing marine engines and boilers. The need of such a work has been felt by most engineers engaged in the construction and working of marine engines, not only by the younger men, but also by those of greater experience. The fact that the original German work was written by the chief engineer of the famous Vulcan Works, Stettin, is in itself a guarantee that this book is in all respects thoroughly up-to-date, and that it embodies all the information which is necessary for the design and construction of the highest types of marine engines and boilers. It may be said that the motive power which Dr. Bauer has placed in the fast German liners that have been turned out of late years from the Stettin Works represent the very best practice in marine engineering of the present day. The work is clearly written, thoroughly systematic, theoretically sound; while the character of the plans, drawings, tables, and statistics is without reproach. The illustrations are careful reproductions from actual working drawings, with some well-executed photographic views of completed engines and boilers. 744 pages, 550 illustrations and numerous tables. Cloth. Price .... **$9.00 net**

MINING

Ore Deposits, with a Chapter on Hints to Prospectors. By J. P. JOHNSON.

This book gives a condensed account of the ore deposits at present known in South Africa. It is also intended as a guide to the prospector. Only an elementary knowledge of geology and some mining experience are necessary in order to understand this work. With these qualifications, it will materially assist one in his search for metalliferous mineral occurrences and, so far as simple ores are concerned, should enable one to form some idea of the possibilities of any he may find. Illustrated. Cloth. Price **$2.00**

Practical Coal Mining. By T. H. COCKIN.

An important work, containing 428 pages and 213 illustrations, complete with practical details, which will intuitively impart to the reader not only a general knowledge of the principles of coal mining, but also considerable insight into allied subjects. The treatise is positively up-to-date in every instance, and should be in the hands of every colliery engineer, geologist, mine operator, superintendent, foreman, and all others who are interested in or connected with the industry. 3d Edition. Cloth. Price **$2.50**

Physics and Chemistry of Mining. By T. H. BYROM.

A practical work for the use of all preparing for examinations in mining or qualifying for colliery managers' certificates. The aim of the author in this excellent book is to place clearly before the reader useful and authoritative data which will render him valuable assistance in his studies. The only work of its kind published. The information incorporated in it will prove of the greatest practical utility to students, mining engineers, colliery managers, and all others who are specially interested in the present-day treatment of mining problems. 160 pages, illustrated. Price **$2.00**

PATTERN MAKING

Practical Pattern Making. By F. W. Barrows.

This book, now in its second edition, is a comprehensive and entirely practical treatise on the subject of pattern making, illustrating pattern work in both wood and metal, and with definite instructions on the use of plaster of paris in the trade. It gives specific and detailed descriptions of the materials used by pattern makers, and describes the tools, both those for the bench and the more interesting machine tools, having complete chapters on the Lathe, the Circular Saw, and the Band Saw. It gives many examples of pattern work, each one fully illustrated and explained with much detail. These examples, in their great variety, offer much that will be found of interest to all pattern makers, and especially to the younger ones, who are seeking information on the more advanced branches of their trade.

In this second edition of the work will be found much that is new, even to those who have long practised this exacting trade. In the description of patterns as adapted to the Moulding Machine many difficulties which have long prevented the rapid and economical production of castings are overcome; and this great, new branch of the trade is given much space. Stripping plate and stool plate work and the less expensive vibrator, or rapping plate work, are all explained in detail.

Plain, every-day rules for lessening the cost of patterns, with a complete system of cost keeping, a detailed method of marking, applicable to all branches of the trade, with complete information showing what the pattern is, its specific title, its cost, date of production, material of which it is made, the number of pieces and core-boxes, and its location in the pattern safe, all condensed into a most complete card record, with cross index.

The book closes with an original and practical method for the inventory and valuation of patterns. Containing nearly 350 pages and 170 illustrations. Price **$2.00**

PERFUMERY

Perfumes and Cosmetics: Their Preparation and Manufacture. By G. W. Askinson, Perfumer.

A comprehensive treatise, in which there has been nothing omitted that could be of value to the perfumer or manufacturer of toilet preparations. Complete directions for making handkerchief perfumes, smelling-salts, sachets, fumigating pastilles; preparations for the care of the skin, the mouth, the hair, cosmetics, hair dyes and other toilet articles are given, also a detailed description of aromatic substances; their nature, tests of purity, and wholesome manufacture, including a chapter on synthetic products, with formulas for their use. A book of general as well as professional interest, meeting the wants not only of the druggist and perfume manufacturer, but also of the general public. Among the contents are: 1. The History of Perfumery. 2. About Aromatic Substances in General. 3. Odors from the Vegetable Kingdom. 4. The Aromatic Vegetable Substances Employed in Perfumery. 5. The Animal Substances Used in Perfumery. 6. The Chemical Products Used in Perfumery. 7. The Extraction of Odors. 8. The Special Characteristics of Aromatic Substances. 9. The Adulteration of Essential Oils and Their Recognition. 10. Synthetic Products. 11. Table of Physical Properties of Aromatic Chemicals. 12. The Essences or Extracts Employed in Perfumery. 13. Directions for Making the Most Important Essences and Extracts. 14. The Division of Perfumery. 15. The Manufacture of Handkerchief Perfumes. 16. Formulas for Handkerchief Perfumes. 17. Ammoniacal and Acid Perfumes. 18. Dry Perfumes. 19. Formulas for Dry Perfumes. 20. The Perfumes Used for Fumigation. 21. Antiseptic and Therapeutic Value of Perfumes. 22. Classification of Odors. 23. Some Special Perfumery Products. 24. Hygiene and Cosmetic Perfumery. 25. Preparations for the Care of the Skin. 26. Manufacture of Casein. 27. Formulas for Emulsions. 28. Formulas for Cream. 29. Formulas for Meals, Pastes and Vegetable Milk. 30. Preparations Used for the Hair. 31. Formulas for Hair Tonics and Restorers. 32. Pomades and Hair Oils. 33. Formulas for the Manufacture of Pomades and Hair Oils. 34. Hair Dyes and Depilatories. 35. Wax Pomades, Bandolines and Brillientines. 36. Skin Cosmetics and Face Lotions. 37. Preparations for the Nails. 38. Water Softeners and Bath Salts. 39. Preparations for the Care of the Mouth. 40. The Colors Used in Perfumery. 41. The Utensils Used in the Toilet. Fourth edition, much enlarged and brought up to date. Nearly 400 pages, illustrated. Price. **$5.00**

WHAT IS SAID OF THIS BOOK:

"The most satisfactory work on the subject of Perfumery that we have ever seen."

"We feel safe in saying that here is a book on Perfumery that will not disappoint you, for it has practical and excellent formulæ that are within your ability to prepare readily."

"We recommend the volume as worthy of confidence, and say that no purchaser will be disappointed in securing from its pages good value for its cost, and a large dividend on the same, even if he should use but one per cent. of its working formulæ.—*Pharmaceutical Record.*

PLUMBING

Mechanical Drawing for Plumbers. By R. M. Starbuck.

A concise, comprehensive and practical treatise on the subject of mechanical drawing in its various modern applications to the work of all who are in any way connected with the plumbing trade. Nothing will so help the plumber in estimating and in explaining work to customers and workmen as a knowledge of drawing, and to the workman it is of inestimable value if he is to rise above his position to positions of greater responsibility. Among the chapters contained are: 1. Value to plumber of knowledge of drawing; tools required and their use; common views needed in mechanical drawing. 2. Perspective versus mechanical drawing in showing plumbing construction. 3. Correct and incorrect methods in plumbing drawing; plan and elevation explained. 4. Floor and cellar plans and elevation; scale drawings; use of triangles. 5. Use of triangles; drawing of fittings, traps, etc. 6. Drawing plumbing elevations and fittings. 7. Instructions in drawing plumbing elevations. 8. The drawing of plumbing fixtures; scale drawings. 9. Drawings of fixtures and fittings. 10. Inking of drawings. 11. Shading of drawings. 12. Shading of drawings. 13. Sectional drawings; drawing of threads. 14. Plumbing elevations from architect's plan. 15. Elevations of separate parts of the plumbing system. 16. Elevations from the architect's plans. 17. Drawings of detail plumbing connections. 18. Architect's plans and plumbing elevations of residence. 19. Plumbing elevations of residence (*continued*); plumbing plans for cottage. 20. Plumbing elevations; roof connections. 21. Plans and plumbing elevations for six-flat building. 22. Drawing of various parts of the plumbing system; use of scales. 23. Use of architect's scales. 24. Special features in the illustrations of country plumbing. 25. Drawing of wrought-iron piping, valves, radiators, coils, etc. 26. Drawing of piping to illustrate heating systems. 150 illustrations. Price **$1.50**

Modern Plumbing Illustrated. By R. M. Starbuck.

This book represents the highest standard of plumbing work. It has been adopted and used as a reference book by the United States Government in its sanitary work in Cuba, Porto Rico and the Philippines, and by the principal Boards of Health of the United States and Canada.

It gives connections, sizes and working data for all fixtures and groups of fixtures. It is helpful to the master plumber in demonstrating to his customers and in figuring work. It gives the mechanic and student quick and easy access to the best modern plumbing practice. Suggestions for estimating plumbing construction are contained in its pages. This book represents, in a word, the latest and best up-to-date practice and should be in the hands of every architect, sanitary engineer and plumber who wishes to keep himself up to the minute on this important feature of construction. Contains following chapters, each illustrated with a full-page plate: Kitchen sink, laundry tubs, vegetable wash sink; lavatories, pantry sinks, contents of marble slabs; bath tub, foot and sitz bath, shower bath; water closets. venting of water closets; low-down water closets, water closets operated by flush valves, water closet range; slop sink, urinals, the bidet; hotel and restaurant sink, grease trap; refrigerators, safe wastes, laundry waste, lines of refrigerators, bar sinks, soda fountain sinks; horse stall, frost-proof water closets; connections for S traps, venting; connections for drum traps; soil-pipe connections; supporting of soil pipe; main trap and fresh-air inlet; floor drains and cellar drains, subsoil drainage; water closets and floor connections; local venting; connections for bath rooms; connections for bath rooms, *continued;* examples of poor practice; roughing work ready for test; testing of plumbing systems; method of continuous venting; continuous venting for two-floor work; continuous venting for two lines of fixtures on three or more floors; continuous venting of water closets; plumbing for cottage house; construction for cellar piping; plumbing for residence, use of special fittings; plumbing for two-flat house; plumbing for apartment building, plumbing for double apartment building; plumbing for office building; plumbing for public toilet rooms; plumbing for public toilet rooms, *continued;* plumbing for bath establishment; plumbing for engine house, factory plumbing; automatic flushing for schools, factories, etc.; use of flushing valves; urinals for public toilet rooms; the Durham system, the destruction of pipes by electrolysis; construction of work without use of lead; automatic sewage lift; automatic sump tank; country plumbing; construction of cesspools; septic tank and automatic sewage siphon; water supply for country house; thawing of water mains and service by electricity; double boilers; hot water supply of large buildings; automatic control of hot-water tank; suggestions for estimating plumbing construction. 407 octavo pages, fully illustrated by 57 full-page engravings. Third, revised and enlarged edition, just issued. Price **$4.00**

Standard Practical Plumbing. By R. M. Starbuck.

A complete practical treatise of 450 pages, covering the subject of Modern Plumbing in all its branches, a large amount of space being devoted to a very complete and practical treatment of the subject of Hot Water Supply and Circulation and Range Boiler Work. Its thirty chapters include about every phase of the subject one can think of, making it an indispensable work to the master plumber, the journeyman plumber, and the apprentice plumber, containing chapters on: the plumber's tools; wiping solder; composition and use; joint wiping; lead work; traps; siphonage of traps; venting; continuous venting; house sewer and sewer connections; house drain; soil piping, roughing; main trap and fresh air inlet; floor, yard, cellar drains, rain leaders, etc.; fixture wastes; water closets; ventilation; improved plumbing connections; residence plumbing; plumbing for hotels, schools, factories, stables, etc.; modern country plumbing; filtration of sewage and water supply; hot and cold supply; range boilers; circulation; circulating pipes; range boiler problems; hot water for large buildings; water lift and its use; multiple connections for hot water boilers; heating of radiation by supply system; theory for the plumber; drawing for the plumber. Fully illustrated by 347 engravings. Price **$3.00**

RECIPE BOOK

Henley's Twentieth Century Book of Recipes, Formulas and Processes. Edited by Gardner D. Hiscox.

The most valuable Techno-chemical Formula Book published, including over 10,000 selected scientific, chemical, technological, and practical recipes and processes.

This is the most complete Book of Formulas ever published, giving thousands of recipes for the manufacture of valuable articles for everyday use. Hints, Helps, Practical Ideas, and Secret Processes are revealed within its pages. It covers every branch of the useful arts and tells thousands of ways of making money, and is just the book everyone should have at his command.

Modern in its treatment of every subject that properly falls within its scope, the book may truthfully be said to present the very latest formulas to be found in the arts and industries, and to retain those processes which long experience has proven worthy of a permanent record. To present here even a limited number of the subjects which find a place in this valuable work would be difficult. Suffice to say that in its pages will be found matter of intense interest and immeasurably practical value to the scientific amateur and to him who wishes to obtain a knowledge of the many processes used in the arts, trades and manufacture, a knowledge which will render his pursuits more instructive and remunerative. Serving as a reference book to the small and large manufacturer and supplying intelligent seekers with the information necessary to conduct a process, the work will be found of inestimable worth to the Metallurgist, the Photographer, the Perfumer, the Painter, the Manufacturer of Glues, Pastes, Cements, and Mucilages, the Compounder of Alloys, the Cook, the Physician, the Druggist, the Electrician, the Brewer, the Engineer, the Foundryman, the Machinist, the Potter, the Tanner, the Confectioner, the Chiropodist, the Manicurist, the Manufacturer of Chemical Novelties and Toilet Preparations, the Dyer, the Electroplater, the Enameler, the Engraver, the Provisioner, the Glass Worker, the Goldbeater, the Watchmaker, the Jeweler, the Hat Maker, the Ink Manufacturer, the Optician, the Farmer, the Dairyman, the Paper Maker, the Wood and Metal Worker, the Chandler and Soap Maker, the Veterinary Surgeon, and the Technologist in general.

A mine of information, and up-to-date in every respect. A book which will prove of value to EVERYONE, as it covers every branch of the Useful Arts. Every home needs this book; every office, every factory, every store, every public and private enterprise—EVERYWHERE—should have a copy. 800 pages. Price **$3.00**

WHAT IS SAID OF THIS BOOK:

"Your Twentieth Century Book of Recipes, Formulas, and Processes duly received. I am glad to have a copy of it, and if I could not replace it, money couldn't buy it. It is the best thing of the sort I ever saw." (Signed) M. E. Trux, Sparta, Wis.

"There are few persons who would not be able to find in the book some single formula that would repay several times the cost of the book."—*Merchants' Record and Show Window.*

"I purchased your book, 'Henley's Twentieth Century Book of Recipes, Formulas and Processes,' about a year ago and it is worth its weight in *gold*."—Wm. H. Murray, Bennington, Vt.

"ONE OF THE WORLD'S MOST USEFUL BOOKS"

"Some time ago I got one of your 'Twentieth Century Books of Formulas,' and have made my living from it ever since. I am alone since my husband's death with two small children to care for and am trying so hard to support them. I have customers who take from me Toilet Articles I put up, following directions given in the book, and I have found everyone of them to be fine."—Mrs. J. H. McMaken, West Toledo, Ohio.

RUBBER

Rubber Hand Stamps and the Manipulation of India Rubber. By T. O'Conor Sloane.

This book gives full details on all points, treating in a concise and simple manner the elements of nearly everything it is necessary to understand for a commencement in any branch of the India Rubber Manufacture. The making of all kinds of Rubber Hand Stamps, Small Articles of India Rubber, U. S. Government Composition, Dating Hand Stamps, the Manipulation of Sheet Rubber, Toy Balloons, India Rubber Solutions, Cements, Blackings, Renovating, Varnish, and Treatment for India Rubber Shoes, etc.; the Hektograph Stamp Inks, and Miscellaneous Notes, with a Short Account of the Discovery, Collection and Manufacture of India Rubber, are set forth in a manner designed to be readily understood, the explanations being plain and simple. Including a chapter on Rubber Tire Making and Vulcanizing; also a chapter on the uses of rubber in Surgery and Dentistry. 3rd Revised and Enlarged Edition. 175 pages. Illustrated **$1.00**

SAWS

Saw Filing and Management of Saws. By Robert Grimshaw.

A practical hand-book on filing, gumming, swaging, hammering, and the brazing of band saws, the speed, work, and power to run circular saws, etc. A handy book for those who have charge of saws, or for those mechanics who do their own filing, as it deals with the proper shape and pitches of saw teeth of all kinds and gives many useful hints and rules for gumming, setting, and filing, and is a practical aid to those who use saws for any purpose. Complete tables of proper shape, pitch, and saw teeth as well as sizes and number of teeth of various saws are included. 3rd Edition, Revised and Enlarged. Illustrated. Price. **$1.00**

STEAM ENGINEERING

American Stationary Engineering. By W. E. Crane.

This book begins at the boiler room and takes in the whole power plant. A plain talk on every-day work about engines, boilers, and their accessories. It is not intended to be scientific or mathematical. All formulas are in simple form so that any one understanding plain arithmetic can readily understand any of them. The author has made this the most practical book in print; has given the results of his years of experience, and has included about all that has to do with an engine room or a power plant. You are not left to guess at a single point. You are shown clearly what to expect under the various conditions; how to secure the best results; ways of preventing "shut downs" and repairs; in short, all that goes to make up the requirements of a good engineer, capable of taking charge of a plant. It's plain enough for practical men and yet of value to those high in the profession.
A partial list of contents is: The boiler room, cleaning boilers, firing, feeding; pumps, inspection and repair; chimneys, sizes and cost; piping; mason work; foundations; testing cement; pile driving; engines, slow and high speed; valves; valve setting; Corliss engines, setting valves, single and double eccentric; air pumps and condensers; different types of condensers; water needed; lining up; pounds; pins not square in crosshead or crank; engineers' tools; pistons and piston rings; bearing metal; hardened copper; drip pipes from cylinder jacket; belts, how made, care of; oils; greases; testing lubricants; rules and tables, including steam tables; areas of segments; squares and square roots; cubes and cube root; areas and circumferences of circles. Notes on: Brick work; explosions; pumps; pump valves; heaters, economizers; safety valves; lap, lead, and clearance. Has a complete examination for a license, etc., etc. 3rd Edition. 345 pages, illustrated. Price **$2.00**

Horsepower Chart.

Shows the horsepower of any stationary engine without calculation. No matter what the cylinder diameter of stroke, the steam pressure of cut-off, the revolutions, or whether condensing or non-condensing, it's all there. Easy to use, accurate, and saves time and calculations. Especially useful to engineers and designers. Price . . . . **50 cents**

Modern Steam Engineering in Theory and Practice. By GARDNER D. HISCOX.

This is a complete and practical work issued for Stationary Engineers and Firemen, dealing with the care and management of boilers, engines, pumps, superheated steam, refrigerating machinery, dynamos, motors, elevators, air compressors, and all other branches with which the modern engineer must be familiar. Nearly 200 questions with their answers on steam and electrical engineering, likely to be asked by the Examining Board, are included.
Among the chapters are: Historical: steam and its properties; appliances for the generation of steam; types of boilers; chimney and its work; heat economy of the feed water; steam pumps and their work; incrustation and its work; steam above atmospheric pressure; flow of steam from nozzles; superheated steam and its work; adiabatic expansion of steam; indicator and its work; steam engine proportions; slide valve engines and valve motion; Corliss engine and its valve gear; compound engine and its theory; triple and multiple expansion engine; steam turbine; refrigeration; elevators and their management; cost of power; steam engine troubles; electric power and electric plants. 487 pages, 405 engravings. 3rd Edition. Price **$3.00**

Steam Engine Catechism. By ROBERT GRIMSHAW.

This unique volume of 413 pages is not only a catechism on the question and answer principle but it contains formulas and worked-out answers for all the Steam problems that appertain to operation and management of the Steam Engine. Illustrations of various valves and valve gear with their principles of operation are given. Thirty-four Tables that are indispensable to every engineer and fireman that wishes to be progressive and is ambitious to become master of his calling are within its pages. It is a most valuable instructor in the service of Steam Engineering. Leading engineers have recommended it as a valuable educator for the beginner as well as a reference book for the engineer. It is thoroughly indexed for every detail. Every essential question on the Steam Engine with its answer is contained in this valuable work. 16th Edition. Price **$2.00**

Steam Engineer's Arithmetic. By COLVIN-CHENEY.

A practical pocket-book for the steam engineer. Shows how to work the problems of the engine room and shows "why." Tells how to figure horsepower of engines and boilers; area of boilers; has tables of areas and circumferences; steam tables; has a dictionary of engineering terms. Puts you on to all of the little kinks in figuring whatever there is to figure around a power plant. Tells you about the heat unit; absolute zero; adiabatic expansion; duty of engines; factor of safety; and a thousand and one other things; and everything is plain and simple—not the hardest way to figure, but the easiest. 2nd Edition. Price . . **50 cents**

Engine Tests and Boiler Efficiencies. By J. BUCHETTI.

This work fully describes and illustrates the method of testing the power of steam engines, turbines and explosive motors. The properties of steam and the evaporative power of fuels. Combustion of fuel and chimney draft; with formulas explained or practically computed. 255 pages, 179 illustrations. Price **$3.00**

Engine Runner's Catechism. By ROBERT GRIMSHAW.

A practical treatise for the stationary engineer, telling how to erect, adjust, and run the principal steam engines in use in the United States. Describing the principal features of various special and well-known makes of engines: Temper Cut-off, Shipping and Receiving Foundations, Erecting and Starting, Valve Setting, Care and Use, Emergencies, Erecting and Adjusting Special Engines.
The questions asked throughout the catechism are plain and to the point, and the answers are given in such simple language as to be readily understood by anyone. All the instructions given are complete and up-to-date; and they are written in a popular style, without any technicalities or mathematical formulæ. The work is of a handy size for the pocket, clearly and well printed, nicely bound, and profusely illustrated.
To young engineers this catechism will be of great value, especially to those who may be preparing to go forward to be examined for certificates of competency; and to engineers generally it will be of no little service, as they will find in this volume more really practical and useful information than is to be found anywhere else within a like compass. 387 pages. 7th Edition. Price **$2.00**